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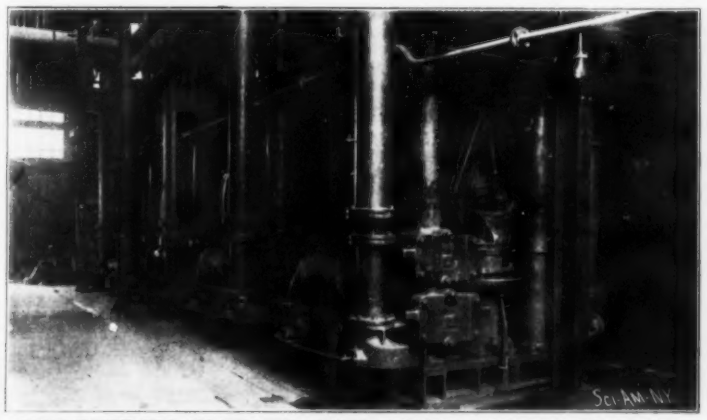
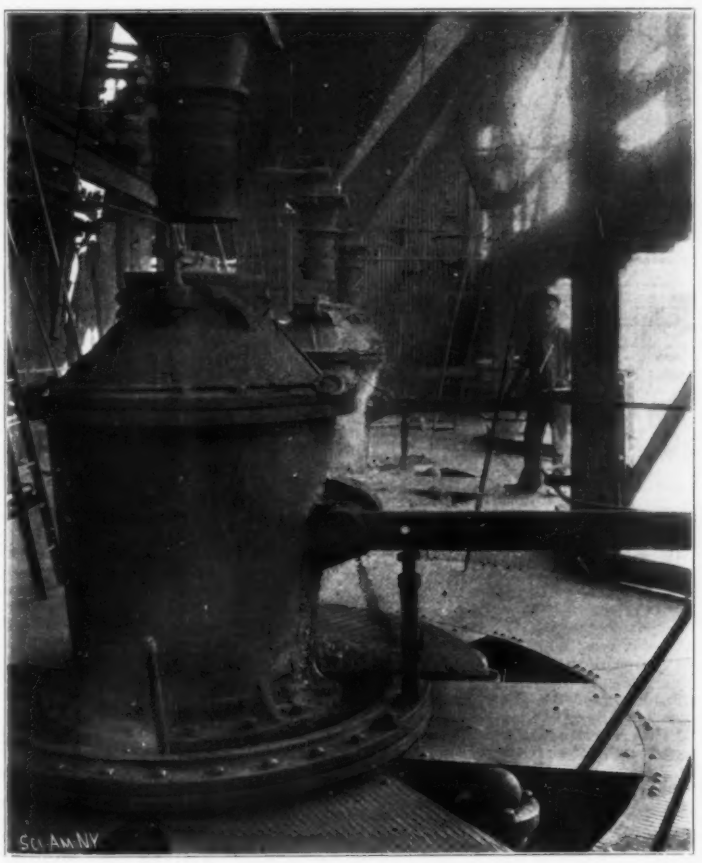
TWO MOND GAS PRODUCERS, YIELDING ABOUT 3,000,000 CUBIC FEET OF GAS PER DAY.



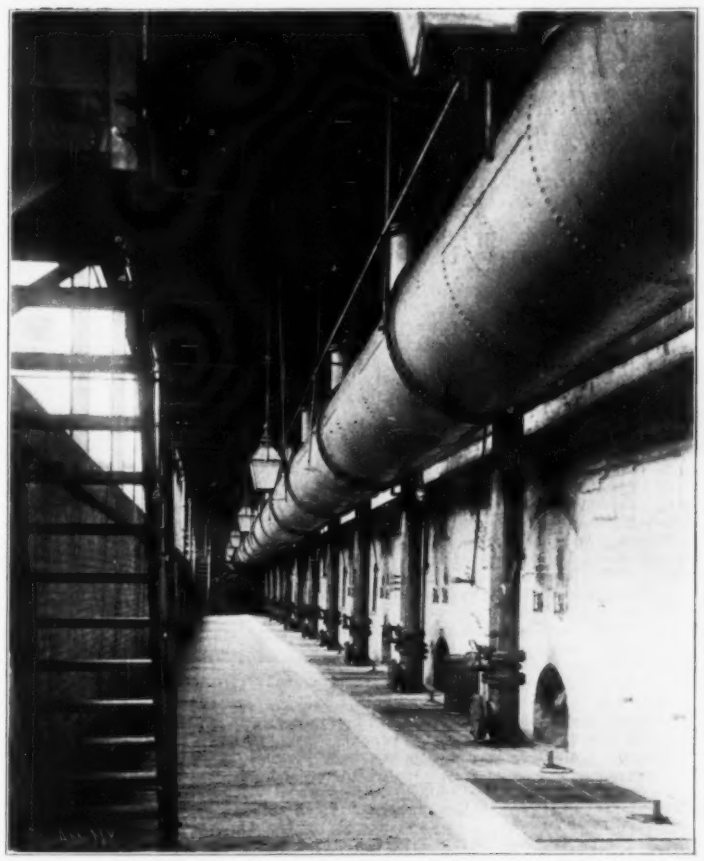
PUMP-HOUSE FOR CIRCULATING WATER USED IN REGENERATING HEAT.

VIEW ABOVE PRODUCERS, SHOWING CREEPERS AND HOPPERS FOR HANDLING SLACK.



THE TOP OF THE PRODUCERS OF A MOND GAS PLANT.

Slack hoppers appear above and measuring hoppers at the center. The ball valves of the producers are also shown.



A ROW OF FURNACES FIRED WITH MOND GAS.

One man attends the whole battery.

THE MANUFACTURE AND UTILIZATION OF MOND PRODUCER GAS FOR INDUSTRIAL PURPOSES.

THE MANUFACTURE AND UTILIZATION OF MOND PRODUCER GAS FOR INDUSTRIAL PURPOSES.*

ALTHOUGH the possibility of utilizing producer gas for manufacturing purposes is by no means a recent undertaking, yet it is only within the last thirty years that any practical attempts have been made to employ it for heating and power producing purposes. The first practical apparatus was that of Bischof, invented in 1839; but, as is the case with so many inventions, it was in advance of the time. Industrial processes at that time were, comparatively speaking, only in their infancy, and there was more than enough of the finest kind of coal available for the exigencies of manufacturing. Consequently Bischof's invention lapsed into desuetude until 1871, when Sir William Siemens, the eminent electrician and engineer, with the assistance of his brother, Frederick, introduced what is now so widely known as the Siemens gas producer.

Owing to the development of industry, it became imperative that some cheaper fuel than coal should be pressed into service, so as to decrease the cost of production, and Siemens was rapidly followed by other though yet similar producer gases, the most important of which are those invented by Wilson, Dowson, Duff, and Mond. It is the last process, however, which has within recent years forged to the front as being the cheapest and most economical fuel in lieu of coal and applicable to gas combustion engines. Furthermore, the Mond invention is the first system in which ordinary slack can be used for gas producing, the gas thus obtained being equally available for either heating or power purposes.

The most important advantage accruing from the employment of producer gas is its lower cost over other forms of fuel, such as coal or coke for steam engines, or the ordinary gas distilled from coal as generally employed in gas engines. For the latter system of generating power it is specially advantageous and renders the gas engine considerably cheaper to operate than the steam engine. With the latter system of supplying power 90 per cent of the heat value of the coal is wasted, while in the most modern engines and boilers only from five to ten per cent of the original heat units appear in the form of mechanical work accomplished.

The producer gas commercially known as the Mond is the invention of the late Dr. Ludwig Mond, a German chemist, and its most salient characteristics over other fuels of this type are that not only can the gas be manufactured from the commonest slack, but that several of the by-products of the manufacture of the gas are obtained, the most valuable of which is the sulphate of ammonia. Furthermore, it is far cheaper to obtain in large quantities than in small bulk, while the process of manufacture is more complete than in the generation of gas from the ordinary coal. The gas which is obtained from the latter by the process of distillation, and which is so extensively employed for illuminating and heating purposes, is by no means thoroughly completely manufactured, seeing that some 70 per cent of the combustible matter contained in the coal is withdrawn in the form of coke from the retorts even after the gas is obtained, and this can be further employed for the generation of power, inasmuch as even in this form it is combustible and extensively utilized. On the other hand, in the Mond gas producer the whole of the combustible matter present in the coal is converted into gas, leaving behind only the ash residue, which it is impossible to consume.

The apparatus employed in obtaining producer gas consists essentially of a closed vessel in which is placed a deep bed or stratum of incandescent fuel. Through this a blast of steam and air are forced and partial combustion of the gas ensues. But the amount of coal actually consumed in the production of the gas is the minimum requisite to generate the heat necessary for the decomposition of the coal and a certain proportion of the steam, thereby converting them into a highly inflammable gas containing hydrogen, carbon monoxide, and methane gas as the combustible constituents, and carbon dioxide and nitrogen as the non-combustible products. The superior advantage of the manufacture of producer gas over ordinary illuminating gas may be deduced from the fact that whereas in the manufacture of the latter from one ton of coal, only 10,000 cubic feet are obtained, 150,000 feet of producer gas are obtained from the same bulk of coal. Though the former gas possesses a calorific value four times in excess of the latter of the same volume, the available heat units from the aggregate quantity of producer gas from the ton of coal is nearly four times as great as that from the volume of the illuminating gas obtained from the same weight.

At Winnington, Cheshire, Dr. Mond has established a gas-producing plant, and at this installation 200 tons of coal are converted into producer gas at the rate of 1,000,000 feet per hour. Only the commonest coal, the bituminous slack which is not of any value for other purposes, is employed. This is purchased at the colliery mouth at the average price of 60 or 75 cents per ton. Delivery to the gas-producing works increases the initial value to $1.25 to $2 per ton. It is then transferred into the huge retorts shown in our illustration and the process of manufacture proceeds. At Winnington there are twelve of these producers, each capable of treating 20 tons of coal per day. The cost of production is so low that the producers are prepared to supply it at 6 cents per 1,000 feet, and they are at present supplying one concern with the fuel at the extraordinarily nominal figure of 4 cents per 1,000 cubic feet. The gas is remarkably free from dust, so that no undue wear and tear is imposed upon the engines driven by it, and indeed, in some instances, owing to its high standard of purity, the machinery utilizing it has not been cleaned for several months.

The ammonia is obtained from the coal by a patent system devised by Dr. Mond. Indeed, it is obtained in sufficiently large quantities to render it commercially remunerative to obtain this by-product. Sulphate of ammonia can be obtained in the illuminating distillation process, but the quantity is somewhat small, being only about 20 pounds to the ton of coal. In the Mond process, however, 90 pounds of sulphate of ammonia results, and, as this is worth $2, therefore the cost of the coal is at least defrayed, leaving the prices obtained by the sale of the gas as profit, while if the production plant is placed in an advantageous position whereby the carriage of raw material is economized, a profit of $1 upward per ton may be obtained from this by-product alone.

In order that this valuable product may be obtained from the coal it is necessary to keep the temperature of the retort or producer down somewhat, otherwise it would escape in the form of nitrogen and hydrogen gases. A volume of steam equivalent to two and a half tons of coal in weight is blown into the producer. There is another aspect to this process which opens up a wide field of possibilities. Owing to the imperative necessity of regenerating with nitrogen the soil upon which cereals, especially wheat, are cultivated, the manufacture of producer gas can be turned to very profitable account in the production of artificial fertilizers. Another advantage of this gas is that it is by no means so poisonous as water gas, as it only contains 11 per cent of carbon monoxide.

The gas produced at Winnington is employed for the heating of a battery of sixty furnaces, and driving gas engines aggregating 1,300 horse power. It is in this latter connection that the value of this gas asserts itself, for it will enable the larger types of engines which are of 1,000 horse power to be driven much more economically than is at present possible with the ordinary illuminating coal gas. As an engine of this power consumes about 75,000 cubic feet of gas per hour, the volume of producer gas obtained from one ton of the commonest slack coal and costing, say, 4 cents per 1,000 feet, the cost of fuel to this high-powered type of engine will amount only to $3 per hour—a distinct saving over the ordinary gas.

Some time ago the company operating the Mond patents in Great Britain applied to Parliament for permission to install a huge system of supplying industrial manufactories in the Black country with this producer gas over an area of 135 square miles. The scheme was to erect five enormous central gas-producing plants, distributed throughout this area, and to supply gas through mains in the orthodox manner direct to the various factories. The company agreed to supply this fuel for power purposes at a price varying from 4 cents to 6 cents per 1,000 feet. Owing to the revolutionary character of the project, and its feasibility, permission to carry the scheme through was granted, and the company is engaged in the erection of the necessary plant, each of which is to serve an area of approximately 27 square miles, and the gas will be conveyed through mains with an aggregate supply of 60,000,000 cubic feet of the gas daily. In this manner the company anticipate supplying 250,000,000 cubic feet at least of producer gas annually. At first only those manufactories guaranteeing to consume 1,000,000 feet per annum will be supplied. The pressure of the gas in the mains will be 7 pounds per square inch maximum, decreasing to 2 pounds per square inch in the branch pipes. In order to reduce the cost of manufacturing the gas to the minimum, the stations will be erected as near coal fields as possible, so that no undue expense will be incurred in the transit of the raw slack from the coal to the producing plant.

Not only will thus the various articles manufactured at the works so supplied by producer gas be made cheaper, but there will be an entire absence of that smoke and grime which characterizes the present utilization of coal upon an expensive scale for steam engines. Furthermore the manufacturers will consume to the utmost that fuel which is at their disposal, and none of the gas will be wasted, as is now the case, through the escape of a large proportion of the combustible gases in the coal and other fuel through the chimneys. It will also be much simpler and easier to control the furnaces heated by this agency, and firemen will be entirely dispensed with, one man fulfilling the duties of a number of the former, since it will be necessary to control only a number of taps connecting the gas supply main with the furnaces. By the utilization of gas firing, also, repairs to furnaces will not constitute the heavy item in maintenance as is at present the case, while much more regular temperatures will be maintained with greater simplicity and facility. What is equally important is the collection of what has hitherto been considered a waste product of the collieries, and which will be converted to remuneratively commercial advantage.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

MANUFACTURED MARBLE.

THE mind of the scientist is ever occupied with the investigation of Nature's secrets, delving deeply into the composition of her products, analyzing or decomposing the simple as well as the complex and making known for future generations the percentage of the constituent parts. Quite the reverse is the process pursued by the artisan who is bent upon composing rather than decomposing, upon putting together, building up, imitating the products of Nature. His hand is skilled in fashioning, making by means of art, counterfeits of Nature's works; hence he is called an artificer and the result of his labors artificial. Thus we see the wrecker and the builder progressing side by side, each supplementing the other. The one in advance giving the component parts of a former whole, the other near behind, accepting those parts and creating with them a close imitation of the prototype.

The scientists having disclosed the constituents of marble, the artificer has proceeded to make it by means of his art, or artificially. For this purpose many formulæ are at his hand, but the most serviceable seems to consist of 80 parts of powdered and sifted gypsum, 20 parts of marble dust, and 20 parts of powdered alum (potassium sulphate) stirred together with a 5 per cent solution of strong glue. There are a number of these compositions on the market and they appear under a variety of names, such as stucco, plaster-marble, Parian-marble (referring to the stone from the island of Paros) Carrara-mass (indicating the famous Italian quarries), and others. Without exception they denote a substance, a product of gypsum, which, being mixed to a consistency of paste, may be molded to form, tinted or colored *ad libitum*, and yet possesses the quality of hardening sufficiently to admit of a lustrous polish.

As to the coloring, leaving the details of the chemical reactions till later, it is simply a question of skill or art, depending entirely upon the cleverness of the one who has the work in charge, to imitate, as truly to nature as possible, the delineations, stripes, flames, in fine, the markings to be seen in the best specimens of highly polished marble. Should the workman be endowed with exceptional adroitness he will turn out artificial marble which in appearance and gloss strikingly resembles the natural stone.

In the early stages of the art of ornamenting rooms with plaster-marble—*stucco lustro* as the Italians call it—the walls first received a rough cast or scratch coat, upon which gypsum mortar was laid with a trowel; this also was left rough and upon it was laid a coat of the finest gypsum plaster, also with a trowel, but this time great care was taken to have it as smooth and even as possible; after the marbleizing had been effected the whole was ground down to an even surface preparatory to polishing.

This tedious procedure has been supplanted by a newer and far easier method; it is now possible to obtain artificial marble in perfectly smooth slabs of convenient size, which, having been attached to the walls, only require to be polished. To-day these slabs of manufactured marble are cast or poured upon a highly polished plate of glass, about 2 meters long by 1 meter wide, and 20 millimeters thick.

In a perfectly horizontal or flat position this plate is supported by a framework high enough from the floor to allow the operator to examine the under side of the glass. The thickness of the slab is limited to the height of a detachable rim about the four sides of the glass plate, forming with it a shallow mold. Having selected a corner of the matrix as the best starting point, the metal is poured in and runs evenly over the whole surface, filling the mold to the required height. The workman must look to it that no air bubbles are formed under the mixture between it and the glass to mar the even surface of the slab. After standing for a time the metal begins to stiffen, and when partially set, at least hard enough to bear the weight, strong, well-galvanized iron wire anchors are inserted in the back. These wire anchors serve to attach the slab to the wall, and it is a matter of the greatest importance that they should be well covered with tin. Uncovered iron anchors would rust in the plaster and eventually disclose their presence by discoloring the slab which would be seen upon the wall. After the slab has hardened, remove the rim and shove it off the plate, standing it upon one edge to dry out. The more easily to overcome the attraction which two plane surfaces have for each other when the air has been removed, it is advisable to coat the surface of the glass plate with oil and rub it lightly off with a cloth just before pouring on the plaster. Figures made of pure gypsum possess the dazzling whiteness of the finest Carrara marble. Many kinds of white marble, however, when polished, present a warm yellowish or bluish color-tone; especially is this the case in such grades as have dark veinings. There are no difficulties in the way of imitating the color-tones in artificial marble; one has only to make use of such mixtures as contain, besides gypsum, alum, etc., a small quantity, at most 1 per cent of the total weight, of quick-lime.

Take, for instance, the yellowish cast which is visible upon the surface of ancient Grecian statues, originally of the purest white. To obtain this in the manufactured product it is but necessary to dissolve a small amount of green vitriol (iron sulphate) in the water with which the plaster was mixed; a pale green hydrated ferrous oxide is given off, which in contact with the air is gradually transformed into a rust-colored hydrated sesqui-oxide of iron, which spreads over the whole surface, lending it the warm creamy tints which we perceive in antique *objets d'art*. From the beginning this ancient marble was pure white, but it contained small quantities of crystallized ferrous carbonate which long contact with the oxygen of the air transformed into the oxide of iron. To obtain a bluish tinge it is only needful to substitute crystals of blue vitriol for those of the green vitriol in the mixing water; the contact with the lime causes the formation of hydrated cupric oxide; this is of a pale blue color which, permeating the mass, endows it with the desired bluish tint.

In using these sulphates be particular to do so in very small quantities, for they are very effective and an overdose would spoil the whole slab by giving it an unnatural aspect. Thus it is apparent that, with due regard for the conditions, manufactured marble may be colored to any desired shade, though the cream tints, with all the shadings in red and brown, livid, and black, are the tints oftenest applied.

Upon slabs already tinted cream or bluish, veins of darker shades of the same color may be easily made by tracing them upon the surface with a fine brush or tool dipped into a solution of green vitriol for the former, or blue vitriol for the latter tints; also here it is important that very weak solutions be used, and rather to form the veins with a series of dots than by means of unbroken lines; a sponge is very serviceable for this part of the decorations. Grayish veins are easily produced upon a cream-tinted slab by dipping the sponge into a very weak decoction of gall-nuts. The tannic acid combines with the iron salts, to form dark blue shading to black streaks which show on the plate. If the slab has been prepared with a concentrated solution of green vitriol and then dotted with the gall-nut decoction a mottled grayish marbleizing will result. Such a slab having been covered or washed over with a decoction of gall-nuts, to which a small amount of extract of logwood had been added, would become a light gray or a deep black, depending upon the strength of the decoction and the number of coats it obtained. A very beautiful black is obtained with a slab treated as above if taken when still moist and washed with an aqueous solution of bichromate of potash.

A clear yellow color can be produced upon a dry slab of artificial marble by coating it on the desired

spots with an aqueous solution of sugar of lead and applying the solution as long as the metal will absorb it.

Let these spots dry and then treat them with a very weak solution of bichromate of potash, from which chromate of lead or chrome yellow will result.

By using blue vitriol in combination with bichromate of potash a brownish red is obtained. If it be intended that the copper colors and the lead colors should blend it will be necessary to avoid the use of blue vitriol and use a solution of copper acetate—verdigris—instead.

Having a slab well saturated with green vitriol, by treating it with a solution of yellow prussiate of potash a beautiful blue color is attained, which, provided the solutions employed have been weak, is not obtrusive. If during the manufacture of the slab prepared with green vitriol small crystals of pyrites be intermixed, and the plate when thoroughly set be treated with a strong solution of red prussiate of potash, we shall have most beautiful imitations of that highly prized mineral *lapis lazuli*.

That beautiful reddish tint, flesh color or *rosso antico*, which is often seen in certain kinds of marble, is the most difficult color to produce chemically in artificial marble. The easiest method is through the application of tin-salt followed by decoctions of redwood and logwood with the addition of carmine.

The tin-salt is first dissolved in water and the roily solution filtered through paper; with this the slab is thoroughly impregnated in spots and allowed to dry. The spots are now treated with the extract of redwood with which a solution of soda has been compounded. This produces a very clear red, such as one seldom finds in marble; but by mixing the redwood decoction with the extract of logwood and a little cochineal liquid, a color tone is obtained which closely counterfeits the peculiar red seen in real marble. Green, which does not occur in marble but in the precious serpentine, can only be made by the mixing of yellow and blue. First of all the yellow fundamental color is made by the use of sugar of lead and bichromate of potash; upon this is applied the blue color formed of green vitriol and red prussiate of potash.

The coloration given up to this point does not sink beyond a certain depth into the composition; rarely reaching further than 2 millimeters into a perfectly dry slab. The slabs may, however, be colored through and through by the use of powdered colors added during the mixing. The process demands a thorough mixing of the pulverized colors with the dry plaster, and this is most effectually accomplished in a revolving drum or tumbler. Mineral colors are preferably used for this purpose, such as ocher for yellow shading to brownish, powdered and elutriated or washed hematite for red, manganese for brown, smalt for blue, coal or charcoal for gray to black. Besides the above colors, chrome yellow, mountain green, green cinnabar, are used, in fact any of the artificial colors which are not affected chemically by the component parts of the slabs. The crystalline effects of many kinds of marble are easily reproduced by the addition of powdered mica to the mass. For the imitation of metallic veins very small crystals of pyrites (not powdered pyrites, for this does not come out a golden yellow like the crystals, but black), may be added; the heavy tailings from the manufacture of bronze powders may also be found of service.

The application of the masses which have been colored with water mixtures is effected by pouring them first upon the glass plate, in the form of stripes or ribbons as they occur in nature. To obviate too sharp lines between the white and colored stripes the edges are worked in with a brush, blended, so to speak, and the under surface of the glass permits this to be looked after with great facility. The markings being finished, which must be completed before the mass hardens, the whole is covered with a layer of soft gypsum compound, that is, with white, cream, or red, according to the desired tint of the ground, and the slab allowed to remain upon the form until it is thoroughly set.

The so-called brecciated marble and pudding stone are no doubt formed by nature in this wise: colored marbles have become broken up and the pieces carried along by water to a certain spot where, being piled up, a filtration of lime water has taken place, gradually depositing the lime and cementing the pieces together, holding them till, in time, the concrete becomes as hard as the marble itself. We have therefore but to follow Nature's lead to imitate both the brecciated marble and the pudding stone. First, provide the colored slabs, break them into bits and artfully arrange the bits upon the level surface of the glass plate, to represent any desired design; this done, there remains only to pour over them a mixture of white or slightly colored gypsum plaster to bind them and allow it to harden, and we have our piebald slab. It has been proposed in this regard to make the colored slabs 10 centimeters thick, so that the pieces will be of that thickness, which must in turn be bound together with the same thickness of the white binder or backing. Now this block of marble 10 centimeters thick may be easily sawed into five slabs of 2 centimeters each. Disregarding the fact that the sawing process is tedious, for the artificial product is almost as hard as natural marble, and that the breaking of one or more slabs is well within the possibilities, the results furnish slabs in a rough state which must be planed down to a smooth surface. It seems then that the sawing, planing, and grinding would be more expensive than the making of the single plates by the original process.

To fasten the plates or slabs to the wall, it is necessary to place them in the required position, about 15 centimeters from the wall, which space is to be filled in with the ordinary plaster of Paris paste; this unites with both the wall and the slabs, and, assisted by the anchors, holds them firmly in place. Having cast the slabs upon the smooth surface of the glass, no grinding is necessary and, when the facing of the wall is complete, there remains only the polishing to be done, after which the whole is gone over with a protective covering. As indicated above, the dry polishing is effected by rubbing the surface with a soft woolen cloth and powdered talc. If it be preferable to polish it wet, then perfectly even or smooth blocks of the same material must be provided, dipped in water, and the surface of the slabs rubbed with them until the desired luster is obtained. Wash off the surface with a soft sponge and allow the slab to dry out. The protective covering cannot be applied until the slab is dry enough to absorb the liquid.—Translated from Stein der Weisen.

[Continued from SUPPLEMENT No. 1440, page 23074.]

THE SCHROEDER CONTACT PROCESS OF SULPHURIC ACID MANUFACTURE.*

II. MANUFACTURING.

By GEORGE C. STONE.

ALTHOUGH the possibility of making sulphuric anhydride by catalytic action has been known for many years, the process was of no commercial value until the discovery that it was essential that the gases should be free from certain impurities. As the several experimenters worked with gas from different sources, their troubles were caused by different impurities, and each devised means of purification to suit his individual needs.

In 1899, Schroeder, then with the Actien Gesellschaft für Zinc Industrie vorm. Wilhelm Grillo, of Hamborn, Germany, realizing the difficulty of absolutely purifying the gases, patented a new contact material which accomplishes the results with less platinum than platinized asbestos, and is easily and cheaply regenerated if it becomes inactive. He makes the mass by adding platinum chloride to a solution of a soluble salt or salts, which are not acted on by sulphuric acid or decomposed at the maximum temperature of the reaction, about 600 deg. C. The solution is evaporated, and the residue ignited to drive off the water of crystallization and decompose the platinum chloride. The salt mixture is granulated and is ready for use. It is usually slightly hygroscopic, and should be kept from contact with the air. A small fraction of 1 per cent of platinum in the mass is sufficient, as the porous and granular salt gives the maximum of surface. After considerable experimenting, a plant was constructed at Hamborn which has given excellent results with this mass while using a different system of purification, and a totally different style of converter from any described in previous patents.

The Badische Anilin und Sodafabrik, working with Spanish pyrites, finding that the arsenic in it ruined the contact mass very rapidly, developed a method of purification, the main object of which was to remove the arsenic. At Hamborn, where zinc blende free from arsenic was used as a source of sulphur, this trouble was not encountered, and for a long time Schroeder did not believe that arsenic interfered. He based his opinion on a short run made at Hamborn with gas made in part from arsenical pyrites, the time not being sufficient for the arsenic to affect the contact mass. When the Schroeder process was tried in America the deleterious effects of arsenic were soon apparent, and a method of removing it from the gas was devised. At Hamborn the ores used contained traces of fluorine which occasioned much trouble, owing to the formation of silicon tetrafluoride which precipitated silica on the contact mass. A simple method was found of removing it from the gas, and it now causes no inconvenience. In addition to these two impurities, chlorine and hydrochloric acid caused some unsatisfactory results, but a means has been found for removing them.

The effects of these three impurities are very different. Arsenic is the worst, as it apparently combines with the platinum, permanently ruining the mass. A contact mass that has been acted on for some time by gases containing arsenic will have a considerable portion of the platinum rendered soluble in hydrochloric acid. A mass that has been badly contaminated with arsenic can only be made fit for use by the removal of the latter, which is a complicated and troublesome process.

Silicon tetrafluoride spoils the mass by coating it with a crust of silica which prevents the contact between the gas and platinum. The mass can be rendered active by the ordinary process of regeneration; but it is, of course, better to remove the cause of the trouble.

Chlorine and hydrochloric acid exert merely a temporary effect in reducing the yield, which becomes good again as soon as pure gas is used.

With properly purified gas the mass retains its activity for a very long time; the first plants started in America with proper purifying apparatus are now giving a yield of 96 per cent and over after more than a year's run without regenerating. When it is necessary to regenerate, the mass is spread on a cement floor and sprinkled with a mixture of dilute nitric and hydrochloric acids containing a little sugar, mixed to a stiff paste, allowed to stand for a couple of days, heated to drive off the water and excess of acid, cooled and crushed, when it is ready for use. The mass is often slightly better after it has been regenerated than it was at first.

At present there are twenty-three Schroeder plants built or building, seven in Germany, two in Russia, one in Poland, one in Italy, two in France, one in Chili, one in Mexico, two in South Africa, and six in the United States. Some are using blende, some pyrites, some brimstone, and one a low-grade gold ore. Some of the ores are quite free from objectionable impurities, while others are very impure, which necessitates such difficult methods of purification that it is impossible to give more than a general description of them.

Each has some form of dust catcher next to the burners to take out the coarse dust carried over by the gas; next comes a cooler in which the temperature of the gas is reduced to about that of the air, then scrubbers or washing towers of different kinds depending on the impurities in the ore; these also serve to dry the gas. After the scrubbers come the filters, which are the most important part of the purifying system, as most of the arsenic, the selenium and other volatile impurities are removed by them. The dried and purified gas is drawn from the filters by a positive blower and forced through the preheaters, in which it is heated to between 300 deg. and 400 deg. C., when it immediately enters the converter. Contrary to the experience of the others it is found that, with the Schroeder contact mass, there is no necessity of using any means of regulating the temperature. The sectional converters have given excellent results with vessels large enough to give a production of 10 tons of 66 deg. acid a day. From the converter the gas passes to a cooler in which it is cooled to about 50 deg. C., or slightly above the freezing point of sulphuric anhydride; it then goes through the absorbing system, which consists of various forms of tanks and towers in which it is brought into intimate contact with a large surface of acid. The style of absorbers varies in almost every plant; the efficiency of all the forms tried is good; in fact, almost every form of absorber that brings the gas in contact with a large surface of moderately cool acid works well. The absorption is practically perfect. When the temperature and supply of acid are correct, no vapor can be seen at the escape pipe. The regulation of the acid supply to the absorbers is very simple and once set requires very little attention.

Where only acid of less strength than monohydrate (H_2SO_4) is to be made some form of scrubber tower is the simplest and best absorber; if fuming acid is desired horizontal cylinders are most satisfactory; these are best followed by a tower to absorb the last traces of the anhydride. Acid up to about 40 per cent of free sulphuric anhydride can be made in the absorbers. If stronger acid is required it must be made by distillation.

The tests regularly made in connection with the process are, first, the usual analyses of ore and cinders; second, the determination of the sulphurous anhydride in the entering and exit gases to determine the efficiency of the operation; this is done by the Reich test, which is very simple, and is made by one of the workmen every hour; third, the test of the purity of the gas; the simplest and most certain test we have for this is to blow a small current of the gas continuously through a calcium chloride tube filled with absorbent cotton; if the gas is properly purified, there will be no deposit on, or discoloration of, the cotton in several weeks.

The conversion is good and uniform; at one plant for a month's run the highest day was 97.76 per cent, the lowest 94.47, and the average 96.68. At another plant the lowest single determination in a 77 days' run was 91.48 per cent, the highest 97.43, and the average 95.39. Another converter was added in the latter part of November, which about doubled the capacity. While working with this, the average conversion to the time this was written (a 66 days' run) was 96.08 per cent. The entire time lost by stops from all causes during the 66 days was 60½ hours, 2¼ hours being due to the shutting down of another works which supplied the acid plant with power; 17½ hours were required to remove some absorbers which were not needed, making the total stops due to the plant and process 39¾ hours.

For many months the stops at this plant from all causes have not exceeded 20 hours in any one month. The exact records for the other works are not available, but it seems that their record must be nearly or quite as good.

The conversion seems to be independent of the percentage of sulphur dioxide in the gas within the limits obtainable with any of the burners tried. In the 77 days' run mentioned above, the conversion with gas containing from 3 to 4 per cent of sulphur dioxide was 95.75 per cent, with 4 to 5 per cent gas 95.92, with 5 to 6 per cent gas 95.38, 6 to 7, 95.12. The gas could not be kept above 7 per cent for long enough to obtain reliable results, but it is hoped to continue the experiments later at a small plant now building at Palmerton, Pa.

It is very difficult to determine accurately the proportion which the acid made bears to the sulphur burned, as it is necessary to determine the exact composition and quantity of the acid in each of the numerous absorbers and tanks in the system at the beginning and end of the run. The sampling of the contents of the horizontal absorbers is particularly difficult, as the acid in the upper part is hot, and stronger than the cooler acid below it. Figures could only be obtained accurately for a run of one month at one plant; in this case the sulphur in the acid made and absorbed was 95.01 per cent of the sulphur burned. The comparison of the amount of acid shipped during considerable periods with the sulphur burned at this and other plants confirms these figures.

The cost of the plant is less than that of a chamber and concentrating plant of equal capacity.

The advantage of the contact process is greater the stronger the acid made, the cost being the same per unit of sulphur for all strengths. For acid stronger than 60 deg. B. it is cheaper than chambers; but for 50 deg., and perhaps for 60 deg. B., it has at present but little, if any, advantage.

Considering that an experience of only three years with the Schroeder process has brought it to the point where it is more economical than chambers for the production of strong acid, it does not seem too much to expect that before long it will be able to compete with them successfully in the manufacture of the weaker acids as well.

One application of the process that promises to be of great importance is its use in connection with chamber plants to make strong acid, in place of concentrating in the usual manner. A plant is now being built for this purpose, and there is every reason to believe that it will show a marked economy, both in first cost and in operating expenses.

No other contact process seems to have been tried under such varied conditions as the Schroeder. So far it has in every case succeeded in overcoming the difficulties it has met, and all the plants in which it has been tried are now working successfully.

(To be continued.)

* Read before the Society of Chemical Industry.

Some tests on the strength of paper, made during the past year at the Watertown Arsenal, U. S. A., showed that strong blue print paper had a strength of 9,700 pounds per square inch, while with a linen paper the strength was 9,000 pounds per square inch.

HOME MANUFACTURE AND USE OF UNFERMENTED GRAPE JUICE.*

By GEORGE C. HUSMAN.

INTRODUCTION.

UNFERMENTED grape juice has no doubt been used ever since wine has been made from the grape. The following practical suggestions will enable housewives to put up unfermented juice at the time of the fruit harvest, and thus utilize much fruit that is now annually lost through inability to preserve it in the fresh state. In this form it is a pleasant, wholesome drink and food well adapted to home use. On some farms enough such preventable wastes occur almost every year to largely reduce the possible profits, or even to cause failure to meet the running expenses of the farm. By preventing these wastes an unprofitable farm may often be made profitable.

HISTORICAL NOTES.

Galenius, the Greek physician and writer says (A. D. 131): "A good many Asiatic wines were stored in bottles which were hung in the corner of fireplaces, where, by evaporation, they became dry." This process was called "fumarium."

The Greeks had two kinds of wine, "protopion," or first juice of the grape before pressing, and "denterion," or pressed juice. The Romans called them "vinum primarium" and "vinum secundarium." Some of them drank the juice before fermentation had started, and called it "mustum." After the must or juice had

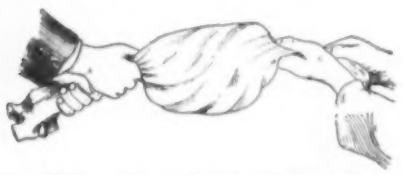


FIG. 1.—CLOTH HAND PRESS.

been through a heating process (called "reduction" nowadays), they called it "frutum," and when, after long heating, it had been reduced to one-half or one-third its original volume, they called it "sapa." This was used by the Romans on their bread and was equivalent to what we now call grape syrup.

In Europe physicians often send their patients to the wine-growing districts during vintage time to take daily rations of the fresh juice as it comes from the crusher. This, however, restricts its use to a brief season of the year and to the immediate vicinity of the vineyards, or to individuals who are yet strong enough to undertake the journey. Of late years repeated efforts have been made to prevent the juice from fermenting and to preserve it in vessels of such size and shape as can be easily transported, thus rendering its use possible at all times of the year. Until recently its use has been almost exclusively restricted to juice for medicinal or sacramental purposes. Unrestricted and general use has been retarded through lack of knowledge of the principles underlying the process of manufacture. This lack of knowledge and of the necessary skill in applying it has resulted in many failures, thus rendering the production of a good article uncertain and expensive.

COMPOSITION OF THE GRAPE.

The grape contains 12 to 28 per cent of sugar, about 2 to 3 per cent of nitrogenous substances, and some tartaric and malic acids. The skins contain tannin, cream of tartar,and coloring matter. The seeds contain tannin, starchy matters, and fat. The stems contain tannin, diverse acids, and mucilaginous matter. The value of the juice made from any grape is deter-

FIG. 2.—CLOTH OR FELT FILTER.

mined by the relative proportion and composition of these various parts.

CAUSES OF FERMENTATION.

It is well known that grapes and other fruits when ripe have the invisible spores of various fungi, yeasts (ferments), and bacteria adhering to their skins and stems. When dry these spores are inert, but after the grapes are crushed and the spores are immersed in the juice they become active and begin to multiply. If the juice is warm, the changes take place rapidly; if, on the other hand, it is cool, the change is slower. But in either case, if left alone, the organisms increase until the juice ferments. The most favorable temperature for fermentation is between 65 deg. and 88 deg. F. Cold checks, but does not kill, the ferment. This fermentation, now commonly called the elliptic yeast, changes the sugar in the grape to alcohol and carbonic-acid gas, and is the leading factor in converting must† into wine. Hence it will be readily seen that to keep grape juice sweet fermentation must be prevented, and to be salable the product must be clear, bright, and attractive.

METHODS OF PREVENTING FERMENTATION.

Fermentation may be prevented in either of two ways:

1. By chemical methods, which consist in the addition of germ poisons or antiseptics, which either kill the germs or prevent their growth. Of these the principal ones used are salicylic, sulphurous, boracic, and benzoic acids, formalin, fluorides, and saccharin. As these substances are generally regarded as adulterants and injurious, their use is not recommended.

2. Mechanical means are sometimes employed. The germs are either removed by some mechanical means, such as filtering or a centrifugal apparatus, or they are destroyed by heat, electricity, etc. Of these, heat has so far been found the most practical.

When a liquid is heated to a sufficiently high temperature all organisms in it are killed. The degree of heat required, however, differs not only with the particular kind of organism, but also with the liquid in which they are held. Time is also a factor. An organism may not be killed if heated to a high temperature and quickly cooled. If, however, the temperature is kept at the same high degree for some time, it will be killed. It must also be borne in mind that fungi, including yeasts, exist in the growing and the resting states, the latter being much more resist-

FIG. 4.—DRIP BAG.

ant than the former. A characteristic of the fungi and their spores is their great resistance to heat when dry. In this state they can be heated to 212 deg. F. without being killed. The spores of the common mold are even more resistant. This should be well considered in sterilizing bottles and corks, which should be steamed to 240 deg. F. for at least fifteen minutes.

Practical tests so far made indicate that grape juice can be safely sterilized at from 165 deg. F. to 176 deg. F. At this temperature the flavor is hardly changed, while at a temperature much above 200 deg. F. it is. This is an important point, as the flavor and quality of the product depend on it.

This bulletin being intended for the farmer or the housewife only, the writer refers such readers as desire to go into the manufacture of grape juice in a systematic manner for commercial purposes to Bulletin 24, Bureau of Plant Industry, Department of

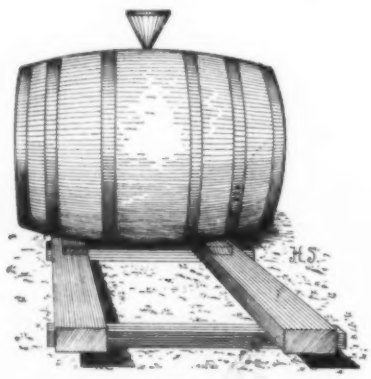


FIG. 5.—BARREL AND SKID.

Agriculture, on the same subject, this publication treating only of methods that can be applied in every home.

HOME MANUFACTURE.

Use only clean, sound, well-ripened but not overripe grapes. If an ordinary cider mill is at hand, it may be used for crushing and pressing, or the grapes may be crushed and pressed with the hands. If a light-colored juice is desired, put the crushed grapes in a cleanly washed cloth sack and tie up. Then either hang up securely and twist it or let two persons take hold, one on each end of the sack (Fig. 1), and twist until the greater part of the juice is expressed. Then gradually heat the juice in a double boiler or a large stone jar in a pan of hot water, so that the juice does not come in direct contact with the fire, at a temperature of 180 deg. to 200 deg. F., never above 200 deg. F. It is best to use a thermometer, but if there be none at hand heat the juice until it steams, but do not allow it to boil. Put it in a glass or enameled vessel to settle for twenty-four

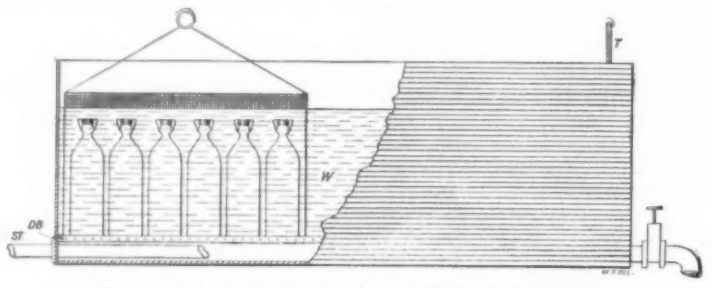


FIG. 3.—PASTEURIZER FOR JUICE IN BOTTLES.

DB, Double bottom. *ST*, Steam pipe. *W*, Water bath. *T*, Thermometer. (Bottle shows method of adjusting a cork holder of sheet metal.)

hours; carefully drain the juice from the sediment, and run it through several thicknesses of clean flannel, or a conic filter made from woolen cloth or felt may be used. This filter is fixed to a hoop of iron, which can be suspended wherever necessary (Fig. 2). After this fill into clean bottles. Do not fill entirely, but leave room for the liquid to expand when again heated. Fit a thin board over the bottom of an ordinary wash boiler (Fig. 3), set the filled bottles (ordinary glass fruit jars are just as good) in it, fill in with water around the bottles to within about an inch of the tops, and gradually heat until it is about to simmer. Then take the bottles out and cork or seal immediately. It is a good idea to take the further precaution of sealing the corks over with sealing wax or paraffin to prevent mold germs from entering through the corks. Should it be desired to make a red juice, heat the crushed grapes to not above 200 deg. F., strain through a clean cloth or drip bag, as shown in Fig. 4 (no pressure should be used), set away to cool and settle, and proceed the same as with light-colored juice. Many people do not even go to the trouble of letting the juice settle after straining it, but reheat and seal it up immediately, simply setting the vessels away in a cool place in an upright position where they will be undisturbed. The juice is thus allowed to settle, and when wanted for use the clear juice is simply taken off the sediment. Any person familiar with the process of canning fruit can also preserve grape juice, for the principles involved are identical.

One of the leading defects so far found in unfermented juice is that much of it is not clear, a condition which very much detracts from its otherwise attractive appearance and due to two causes already alluded to. Either the final sterilization in bottles has been at a higher temperature than the preceding one, or the juice has not been properly filtered or has not been filtered at all. In other cases the juice has been sterilized at such a high temperature that it has a dis-

FIG. 6.—SULPHUR HOOK.

agreeable scorched taste. It should be remembered that attempts to sterilize at a temperature above 195 deg. F. are dangerous, so far as the flavor of the finished product is concerned.

Another serious mistake is sometimes made by putting the juice into bottles so large that much of it becomes spoiled before it is used after the bottles are opened. Unfermented grape juice properly made and bottled will keep indefinitely, if it is not exposed to the atmosphere or mold germs; but when a bottle is once opened it should, like canned goods, be used as soon as possible, to keep it from spoiling.

MANUFACTURE OF LARGER QUANTITIES.

Another method of making unfermented grape juice, which is often resorted to where a sufficiently large quantity is made at one time, consists in this:

Take a clean keg or barrel (one that has previously been made sweet). Lay this upon a skid consisting of two scantlings or pieces of timber of perhaps 20 feet long, in such a manner as to make a runway (Fig. 5). Then take a sulphur match, made by dipping strips of clean muslin about 1 inch wide and 10 inches long into melted brimstone, cool it and attach it to a piece of wire fastened in the lower end of a bung and bent over at the end, so as to form a hook (Fig. 6). Light the match and by means of the wire suspend it in the barrel, bung the barrel up tight, and allow it to burn as long as it will. Repeat this until fresh sulphur matches will no longer burn in the barrel.

Then take enough fresh grape juice to fill the barrel one-third full bung up tight, and roll and agitate violently on the skid for a few minutes. Then burn more sulphur matches in it until no more will burn, fill in more juice until the barrel is about two-thirds full,

* Farmer's Bulletin 175. United States Department of Agriculture.

† The word "must" as used in wine making invariably refers to the unfermented juice of the grape and is so used in this publication.

agitate and roll again. Repeat the burning process as before, after which fill the barrel completely with grape juice and roll. The barrel should then be bunged tightly and stored in a cool place with the bung up, and so secured that the package can not be shaken. In the course of a few weeks the juice will have become clear and can then be racked off and filled into bottles or jars direct, sterilized, and corked or sealed up ready for use. By this method, however, unless skillfully handled, the juice is apt to have a slight taste of the sulphur.

A FEW USEFUL APPLIANCES.

Fig. 7 shows a very practical and inexpensive corking machine. The illustration shows the cork in place, ready to be driven through the tapering hole in the machine into the neck of the bottle underneath. The corks should be put in hot water and allowed to stand for a few minutes before using in order to soften and make them pliable. This enables one to use a cork large enough to seal securely.

Care should be taken to set the bottles on a flat piece of rubber or on a piece of cloth folded several times, as shown in the figure, so as to take the jar of the blow when the cork is driven. It is even a wise precaution to have a pan underneath, as it frequently occurs that bottles thought to be entirely good have blemishes and break.

An ordinary cider press is not expensive; nevertheless the majority of farms do not have one, and it frequently occurs that a farm is located so far away from any establishment dealing in such implements that the fruit might spoil or not be sufficiently valuable to justify the purchase price and time lost and expense incurred in getting it. Fig. 8 gives an illustration of a lever press, very efficient for this and similar uses, which any farmer handy with tools can make, the material for which can be found on almost any farm at any time. The press consists of the following parts:

Two upright posts, *F*, set deep and firmly in the ground side by side and about 12 inches apart. (It is a good idea to attach some deadmen to them in the ground to prevent them pulling out too easily.) Between these posts the lever, *E*, is hung by means of a bolt, *T*, or the lever may be hung to the side of a building, or a hole notched into a tree large enough to admit the end of the lever and a bolt run through that. At the other end of the lever are two posts, so set that the lever can be raised up between them by means of block and tackle. The press itself consists of two timbers, *D*, on which the press bottom, *B*, rests, and on this bottom is the press basket, consisting of the two sides and two ends, and so constructed that it can easily be taken apart and set up again, being held together at the ends by means of rods, *L*. The sides and ends should be bored full of small holes from three-eighths to one-half inch in diameter to allow exit for the juice.

After the press is filled, the top (which is made to fit in the inside of the basket) and cross blocks, *I*, are put on and the lever is then allowed to press down on it. A press like this has the advantage that it can be filled in the evening and left to press until morning, while the farmer sleeps. The precaution, of course, must be taken to set a tub, *C*, large enough to hold the juice under the press.

It is perhaps well to state that the longer and heavier the lever the greater the pressure it exerts. Where it is not convenient to make the lever very long, weights are placed or hung on the outer extremity of the lever to increase the pressure. It will thus be seen that with a little ingenuity a person can adapt the press to suit his individual requirements.

For ordinary purposes a press basket 3 feet square and 2 feet high will be found a very convenient size. This will accommodate a ton of crushed grapes.

COMPOSITION OF UNFERMENTED GRAPE JUICE.

Herewith are given the component parts of a California and a Concord unfermented grape juice, the former being analyzed by the California Experiment Station, the latter by the Bureau of Chemistry, United States Department of Agriculture:

	Concord.	California.
	Per cent.	Per cent.
Solid contents	20.37	20.60
Total acids (as tartaric)	.663	.53
Volatile acids	.023	.03
Grape sugar	18.54	19.15
Free tartaric acids	.025	.07
Ash	.255	.19
Phosphoric acids	.027	.04
Cream of tartar	.55	.59

This table is interesting in so far that California unfermented grape juices are made from Viniferas or foreign varieties, whereas the Concord is a Labruska or one of our American sorts. The difference in taste and smell is even more pronounced than the analysis would indicate.

FLAVOR AND QUALITY IN GRAPE JUICE.

In the making of unfermented grape juice a great deal of judgment can be displayed and many variations produced so as to suit almost any taste by the careful selection of the varieties of grapes from which it is made. From the Mission grape, for instance, when fully ripe, a juice would be obtained that would be delicate and simply sweet, without any other taste; from the Muscat we would get that rich musky flavor found in our leading raisins; in the Concord that sprightly foxy taste so well known; in the Catawba or Isabella that fragrance so peculiarly their own, and in the Iona a pleasing, mild, yet just pronounced enough aroma and taste to strike the right spot. Thus we might continue along the list.

Equally as pronounced variations in color can be had, as, for instance, almost colorless, yellow, orange, light red, red, and a deep purple.

The writer has often been asked what kind of grapes should be used in making unfermented grape juice, when, as a matter of fact, it can be made from any grape; not only this, but unfermented juice is made from other fruits as well, for instance, apples, pears, cherries—and berries of different kinds yield excellent juices. It is really good judgment in selecting the right varieties when planting for fruit production. That also determines the quality of our unfermented juice. For instance, the richer, sweeter, and better in quality the fruit we use, the richer, sweeter, and better will be our unfermented juice. If, on the other hand, the fruit is sour, green, and insipid, the juice will be likewise. As stated before, the

FIG. 7.—CORKING MACHINE.

intention of this bulletin is to show how to avoid some wastes, and to increase income by utilizing those products of which there is a surplus, and instead of, as is usually done, letting them rot, convert them into something that can be kept, used, and disposed of at any time when desired, or when fresh fruit is not available.

USES OF UNFERMENTED GRAPE JUICE.

The uses are indeed many. It is used in sickness, convalescence, and good health; as a preventive, restorative, and cure; by the young, by persons in the prime of life, and by those in old age. It is used in churches for sacramental purposes; at soda fountains as a cool and refreshing drink; in homes, at hotels, and at restaurants as a food, as a beverage, as a dessert, and in many other ways. When people become accustomed to it they rarely give it up. When properly prepared, unfermented grape juice can be made to please the eye by its color and attractive appearance, the sense of smell by its aroma or fragrance, the palate by its pleasant flavor.

It is food and drink, refreshment and nourishment, all in one. Not a by-product, but made from fruit going to waste—one of the blessings given us, that some are too careless, others too ignorant, to make use of.

FOOD VALUE OF UNFERMENTED GRAPE JUICE.

The effects of unfermented grape juice on the human system have been studied for a number of years, especially at the so-called grape cures so long in vogue in Europe. A smaller number of investigations have been made in laboratories.

It is quite generally claimed that using a reasonably large amount of unfermented grape juice with an otherwise suitable mixed diet is beneficial and that digestion is improved, intestinal fermentation diminished, and that gains in body weight result. It should not be forgotten that the abundant diet and hygienic methods of living practiced at the grape cures play an important part, but even taking all this into account it seems fair to conclude that some of the good results can be directly attributed to the unfermented grape juice.

Grape juice contains the same kinds of nutrients as other foods. The percentage of water is high, and thus it resembles liquid foods more closely than solid foods. It is sometimes compared with milk, the most common liquid food. It contains less water than milk, more carbohydrates, and less protein, fat, and ash. Carbohydrates, largely present in the form of sugar, are the principal nutritive ingredients. It is evident, therefore, that grape juice is essentially an energy-yielding food, and may help the body to become fatter, though it cannot materially assist in building nitrogenous tissue. Sugars in moderate amounts are wholesome foods, and grape juice offers such material in a reasonably dilute as well as palatable form. Undoubtedly the agreeable flavor increases the appetite, a by no means unimportant consideration.

A FEW GOOD RECIPES.

Grape Nectar.

Take the juice of 2 lemons and 1 orange, 1 pint of grape juice, 1 small cup of sugar, and a pint of water. Serve ice cold. If served from punch bowl, sliced lemon and orange add to the appearance.

An Invalid Drink.

Put in the bottom of a wineglass 2 tablespoonfuls of grape juice; add to this the beaten white of 1 egg and a little chopped ice; sprinkle sugar over the top and serve. This is often served in sanitariums.

Grape Punch.

Boil together 1 pound of sugar and half a pint of water until it spins a thread; take from the fire and when cold add the juice of 6 lemons and a quart of grape juice. Stand aside overnight. Serve with plain water, apollinaris, or soda water.

Grape Sherbet.

For 8 persons mix 1 pint of grape juice (unfermented), juice of lemon, and 1 heaping tablespoonful of gelatine, dissolved in boiling water; freeze quickly; add beaten white of 1 egg just before finish.

Grape Ice Cream.

One quart of unfermented grape juice, 1 quart of cream, 1 pound of sugar, and the juice of 1 lemon.

Syllabub.

One quart of fresh cream, whites of 4 eggs, 1 glass of grape juice, 2 small cups of powdered sugar; whip half the sugar with the cream, the balance with the eggs; mix well; add grape juice and pour over sweetened strawberries and pineapples, or oranges and bananas. Serve cold.

Bohemian Cream.

One pint thick cream, 1 pint grape-juice jelly; stir together; put in cups and set on ice. Serve with lady fingers.

Besides the recipes just given many more are enumerated, such as grape ice, grape lemonade, grape water ice, grape juice and egg, baked bananas, snow pudding, grape gelatine, junket and grape jelly, tutti-frutti jelly, grape float, grape jelly, grape juice plain, grape soda water, and scores of others.

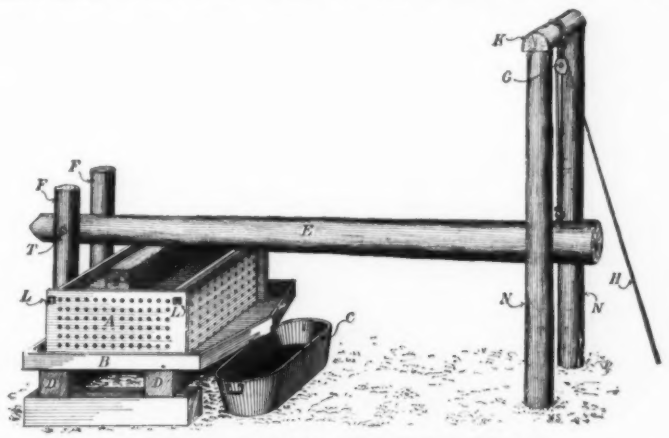


FIG 8.—HOME-MADE LEVER PRESS.

A, Press basket. *B*, Press bottom. *C*, Tub. *D*, Skids. *E*, Lever. *F*, Upright posts. *G*, Block and tackle. *T*, Lever bolt. *I*, Press block.

THE METRIC SYSTEM IN INDIA.

ON a reference from the Chief Collector of Customs in Sind, the government of India, after consulting the Secretary of State, recently gave orders for the recognition by the Customs authorities of the metric system of count for the marking and description of woollen and silk yarns imported from the Continent. The Chief Collector pointed out that, although the worsted yarn in respect to which the reference was made had not so far competed with British goods of similar make, British trade might in future be prejudiced by foreign yarn being permitted to be marked with a higher number than its British equivalent. The Chambers of Commerce in this country specially interested in the question were consulted, but raised no objection to the recognition of the metric system provisionally made by the Indian government. The recognition was thereupon made permanent, the only conditions imposed being that the marking should be qualified by the words "Continental count" or "metric count" and by a statement of the country of origin. It transpired in the course of the correspondence that the principal consumers of the imports of worsted declined to accept yarn made up otherwise than according to the metric standard to which they had become accustomed. An

expert committee of the Silk Association of Great Britain and Ireland, presided over by Mr. Matthew Blair, of Messrs. M'Lennan, Blair and Co., Glasgow, in view of these and other facts, strongly recommended that, while it would be unnecessary and impolitic to seek by any violent means to abolish the systems of counts or methods of reel now in use, dealers, throwsters, and spinners should adopt the international count in all marking of their goods, in addition to any other count which they consider necessary or convenient. To facilitate this process Messrs. M'Lennan, Blair & Co. have, as already announced in the Times, issued a series of "International Yarn Tables," which have been issued with the hearty approval and thanks of the permanent committee of the Paris International Congress of 1900. The metric count adopted by the conference is, of course, the standard of comparison, and the alphabetical column headings, each devoted to some English, American, or Continental count, more or less well known, are 24 in number. The standard of comparison "meters per gramme" ranges from 1 to 100, thence in numerals of 5 to 600, and then in numerals of 10 to 1,000. The introduction is given in French, German and Italian, as well as English, and the tables will go far to meet the need, set forth by Mr. Blair himself in an explanatory memorandum on the report of the expert committee over which he presided, for a universal language of count, "adapted to every class of fiber and every kind of manufacture, and understood in every country."—London Times.

THE "STATE OF THE ART" IN PATENT CASES.

IN a paper read before the Engineers' Club of Philadelphia, H. Bovie Schermerhorn gave an explanation of what is meant by the term "state of the art" in patent law.

Our government, in granting a patent to an inventor, confers upon him a monopoly of the invention for seventeen years. As a return for this benefit conferred the government demands of the inventor two things: That the invention shall be useful and that it shall be new. The degree of usefulness is immaterial provided the invention be in fact an operative device or apparatus. But on the score of novelty the demand of the government is absolute. Both to obtain a patent and to maintain it after grant it must possess novelty. Otherwise the condition fails upon which the government granted the monopoly and the monopoly is at an end.

The standpoint of the Patent Office and the patent law is the standpoint of the world at large. All they ask is, "Has this that the inventor claims to have done for the first time ever been accomplished before?" If it has, then it matters not that the inventor was totally ignorant of the prior achievement; his application will be rejected.

The patent law, realizing the impossibility of determining the good faith of an inventor, has taken the position that if the state of the art discloses the device, the new-comer cannot claim any title as inventor thereof. The object of the Patent Office is to issue as far as possible one patent for each invention and to avoid the overlapping of inventions or claims in patents issued by the office. Therefore the law broadly assumes the position that an inventor must take notice, as the expression is, of the state of the art, and it results from this that if a patent is inadvertently issued for something which is already embraced in the state of the art, that patent is liable to be invalidated in case this instance of prior publication or prior use, as the case may be, is brought forward against it.

In other words, it is the state of the art and not the inventor's claim, that is used as a standard of measurement by which to ascertain the true degree of novelty exhibited by his invention.

Now, we can explain this expression, "the state of the art," in another way. Let us suppose a given rectangle represents the sum of all the inventions that have gone to make up some piece of machinery which stands to-day in a highly finished form. Let us take, for example, the modern express locomotive. Let us suppose that the area covered by this rectangle represents the total number of inventions going to make up in the aggregate the express locomotive as it stands to-day. The largest single share or slice of this field was that pre-empted by the original inventor of the locomotive, Stevenson. As soon as men's minds were turned toward the possibilities involved in this new application of the expansive force of steam, inventions and improvements along this line followed one another with great rapidity, and the earlier inventions were doubtless of a very high degree of value and covered a field perhaps almost as large as that originally pre-empted by Stevenson, the pioneer inventor. Thus we can mark off successive sections of the total field and we notice that as we reach the end, and in proportion as we reach the end, the area remaining grows less, and we consequently find that to-day an invention in improvement of the locomotive does not go to the whole of the machine, but is a mere improvement upon some pre-existing and well-known part, efficient, useful, but not comparable in any wise to the extent and scope of the earlier inventions along this line. Now, as to the inventors of to-day who wish to improve upon the locomotive, all this immense area stretching away back of them in the shape of prior patents, United States and foreign, that have already been granted for inventions and improvements upon the locomotive, constitute the state of the art, and each new-comer's invention is to be measured by this state of the art extending behind him and its scope and extent determined by that state of the art.

In other words, if to the inventor of to-day the state of the art discloses anywhere in this prior mass of patents an instance of invention substantially equivalent and similar to his own, then he can no longer obtain a patent upon that improvement. If the prior art discloses only a portion of that which he has invented, then he is entitled to a patent for the remainder. It is thus apparent that upon the state of the art depends the question whether there is any invention at all in a given case, and if there be invention, how much invention is shown and may be patented.

We see then how important it becomes, both before applying for a patent and in many instances after the patent has been granted, to determine accurately the state of the art in that particular field of invention. If the inventor is to be fully protected, he must know just the extent of field covered by his invention and adequately claim that field in his patent. To know how much new field his invention covers, he must know to what extent the whole field has already been covered by prior invention, for it is only by placing, so to speak, his own achievement side by side with the sum of past achievements in the direction of his invention, that he can measure his own step in advance.

To throw light upon the state of the art, recourse is had to searches. They are practically divisible into four classes:

1. The search made by the inventor or his attorney preliminary to application.

2. The search made by the Patent Office examiner in charge of the application during its progress to grant and issue.

3. The search made on behalf of prospective purchasers of or investors in the patent, after grant, to determine its strength and scope.

4. The search made by a defendant when sued for infringement and seeking to establish anticipation of the patent as his defense.

1. What the search prior to application covers: The first search usually made is by the inventor or his attorney prior to applying for a patent. This search usually covers prior United States patents along the particular subject-matter of the invention.

2. The Patent Office search covers prior United States patents, also prior foreign patents and to some extent prior publications.

Of course, the ability and skill of the examiners vary in the different divisions of the Office, and the average of ability is fairly high, but the inconclusiveness of their judgment is shown by the fact that out of all the United States patents subjected to the scrutiny of an infringement suit a large number are declared void by the courts because of anticipation by prior United States patents.

This is the second search made to determine the state of the art. Now should the patent issue and the inventor attempt to dispose of his invention to capitalists, those who undertake to put money into an invention for the purpose of exploiting it will rarely do so without making or having made an independent examination into the state of the art, in order to determine the value or validity of the patent.

Such a search, if made by a competent attorney, is usually of more value than either of the two searches preceding, for the reason that we have the advantage of all the information elicited by the preceding examinations and in addition thereto a more complete examination into the prior foreign patents is often made than is made by the United States Patent Office before grant. It is made from a skeptical standpoint, throwing the burden of proof strongly upon the patent to establish clearly its rights. It may and often does cover both the home and foreign field of prior patents more completely than the Washington Office, and the bearing of any prior patents upon the patent in question is apt to be more fully and carefully considered. Through the interests involved, more time and expense are justified than in the search made by the Washington examiner, and a broader field is usually covered by such an examination.

None of these three searches enumerated does or can cover, however, the entire field embraced in the state of the art, for the reason that at most they can only take account of prior United States and foreign patents and of the more notorious instances of prior publication in well-known technical journals and publications.

But this, although an immense field in itself, is by no means the entire field occupied by the state of the art, for we have in addition thereto to reckon with instances of prior use.

It is, in the nature of things, impossible for either the Patent Office or an attorney making an independent examination to ascertain whether a device patented or proposed to be patented has been already in use, since that use may have taken place in any quarter of the United States, and provided it is such a use as answers the requirements of the patent law, it would nevertheless, in spite of its having taken place in an obscure quarter and for a very short period of time, be sufficient to overturn the patent against which it was brought forward.

Therefore we come to the fourth and last examination into the state of the art, which is practically made in connection with letters patent and that is in the course of a suit for its infringement. The defense set up by an infringer is usually divided into two branches; first, non-infringement—that is, that his device as manufactured and sold does not actually in point of mechanical resemblance infringe the plaintiff's patent; and second, that granting that there is infringement in the case, the plaintiff's patent is invalid because anticipated by a prior patent, a prior publication, or an instance of prior use. This latter defense is by far the most common in these cases, and it is this defense which brings up, so far as it is possible to bring it up, the entire state of the art in connection with any patented device involved in such litigation. The interests involved in these suits being frequently very large, both sides are eager, the one to bring forward an instance of anticipation, the other to defend the patent, and the four quarters of the civilized world are usually ransacked for instances of prior publication, prior patent, or prior use.

It is only after a patent has passed this ordeal that it can in any true sense be considered as established, for the reason that it is only in such cases that the state of the art by which the degree of invention shown by a patent is measured is brought forward, if at all, to any complete degree in suits for infringement of letters-patent. All that is then brought forward and passed upon by the court becomes practically *res adjudicata* as to the patent in question.

We thus see over how enormous a field our inquiry must be extended if we would know the precise status and validity of our patent. It is a field co-extensive with the civilized world and the intelligent activity of men.

The foregoing may be considered to present perhaps a very gloomy outlook both for the would-be inventor, the actual patentee, or for those having capital invested in a patent, since it is easy to see that it is quite impossible in the ordinary run of cases fully to ascertain beyond peradventure that the state of the art does not somewhere contain an instance of anticipation. It is only proper, therefore, that we should consider briefly the redeeming features of the situation. In the first place, a very small percentage of the patents granted are subjected to this ordeal of an infringement suit, and in the case of those involved in an infringement suit there still remains the saving grace accorded by the courts in their point of view regarding such patents.

The grant of a patent by the government creates a *prima facie* presumption in favor of the patent. The courts realize that the patent law has been established for eminently utilitarian purposes, to encourage invention and to promote the industries and the useful arts. Therefore they are active to protect a patent involved in suit and to sustain it until and unless an undoubted instance of prior publication or prior use is brought forward against it.

Every intendment is made in favor of the patent, and an instance of prior publication or prior use must, so to speak, be on all fours with the patent before the courts will allow it as an anticipation. Therefore, as wide as may be the field in which an instance of anticipation may be sought and found, it is nevertheless offset by this fact, that it will not do to find an instance of partial anticipation or to bring forward a part of the patent shown in one prior device and another part in another prior device and, putting them together, say there is here an anticipation of the patent. The court requires that the anticipation shall be a prior publication or prior patent or instance of prior use of a device which substantially in all its details answers to the device involved in suit.

The infringer knows that the burden and expense of proving anticipation lie upon himself, while the patentee can stand upon the grant of his patent by the government until it is overthrown. And before it can be overthrown a clear anticipation must be shown. If there is a doubt, it is resolved by the courts in favor of the patentee. The attacking party cannot piece out a machine by taking one part here, another there, and a third elsewhere, and bring the whole forward as an anticipation of the patent in suit. Most patents to-day are for new combinations of elements, all of which, separately considered, are old. Such a patent can only be overthrown by showing the prior use or description of the same elements, or their mechanical equivalents, assembled in a machine performing substantially the same operations. And the more useful or meritorious an invention, the more do the courts incline in its favor when thus attacked, and the stricter the proof they require of clear anticipation.

It may be said, since the United States Patent Office cannot secure an inventor against this state of the art completely, why does it attempt to do so at all? The foreign patent-granting countries, with the exception of Germany, adopt this view and grant to an applicant whatever he claims as his invention, leaving it to the courts or to future circumstances to determine what the extent of his real invention in the premises may be. This was likewise our method prior to 1836. Our method of a partial examination is the better one for several reasons, one of the foremost being that it, in a great many instances, saves inventors from a further expenditure of time and money in the promotion of a patent that is clearly invalid by reason of a prior United States patent granted for the same subject-matter. The inventor being met at the outset by a patent on all fours with his idea is saved from going further, and capital is saved from investment in a patent clearly invalid at the outset. Then, too, our office, if it does not show the application to be invalid *in toto*, acts beneficially to restrict the applicant within the field that he may reasonably be entitled to occupy and thus saves him from an erroneous view as to the extent of the ground his patent may cover. Then, lastly, it should be borne in mind that the popular view is that a patent granted by the government amounts to a guarantee of originality, and this impression, however erroneous it may be, as we have seen, serves to prevent very many would-be infringers from trespassing upon the territory of a patent, as they would undoubtedly do if the field were known to be open to all, as in the case of patents granted abroad, where there is no examination made as to novelty before grant.

While, therefore, the odds against the validity of a patent seem to be very great, they are in effect and in the practical working out of the system much less than they appear to be, and what has been said upon this subject should not be taken as a discouragement either of inventors or inventions, but simply as a statement showing the true position which a patent occupies in the total field of invention.

THE STORY OF TRENT BRIDGE.

IT should be remembered that in early times, says the Nottinghamshire Guardian, the great bridges of the country were not, as nowadays, maintained by local authorities. The expense was too great, and they were always treated as an Imperial burden, borne by the old kings primarily, assisted by the contributions of the charitable. King Edward the Elder built the first bridge over the Trent at Nottingham in the year 921, and in later centuries we read of the Archbishops of York granting indulgences to all such as contributed to its support. But in those times stonework was an unattainable luxury, and timberwork was made to serve in its stead. Hence, no doubt, reparations and rebuildings frequently took place. Not before the year 1300 was a stone Trent Bridge seriously planned, and it was the lady philanthropist of Nottingham—already known as a benefactor of the local White Friary and other charities—who projected and carried out the undertaking.

The story opens with an application by John le Palmer, of Nottingham, and Alice, his wife, for a royal license to give £6 13s. 5d. of yearly rents of Nottingham property for the maintenance of two chaplains, to celebrate divine service for their souls in the chapel of St. Mary on "Hethbeth Bridge," as it was then called. In accordance with custom an in-

quiry was held, in the royal interest, in 1301-02, when it was reported that the proceeding would not be prejudicial to the king, and the desired license was consequently granted on April 16, 1303. In the last-named document it is recorded that the chaplains were to pray not only for the souls of the Palmers and their relatives, but also for the souls of "all Christians who assign their goods, or part of them, to the maintenance of the said bridge." Probably the Palmers were also then assisting in maintaining the structure, although we are not expressly told so. But the chapel of St. Mary—if it ever existed—is heard of no more. The benefactors built or rebuilt it as the chapel of St. James, and, being reared as part of the new bridge, it was not completed and fit for use until 1322.

Of course the Palmers were people of position. John was made Mayor of Nottingham in 1302, 1306, and 1311. His wife, who survived him, was sister and heir to Hugh de Stapleford, of a powerful local family. Possibly it was her money alone that went to found the chantry, as her husband does not again figure in association with the work of the bridge. Probably Alice labored at first in connection with the town authorities. At any rate, on August 28, 1311, there was issued a royal grant to Alice le Palmer and the good men of the town of Nottingham of "pontage" for a term of five years, for the repair of the bridge of Hethbeth—under due supervision. This pontage, as its name implies, was a fund devoted to bridgework, derived from toll on goods entering the town, from whatever direction. Although "repairs" only are alluded to, there is no doubt that the bridge was being reconstructed, the terms being elsewhere confused among contemporary documents. Alice did not remain on cordial terms with the town authorities, for subsequently the latter desired that the same tolls might be diverted to the building of the town wall, as we shall see.

John le Palmer appears to have died soon after completing his term of office as mayor in 1312. On August 26, 1314, was issued a royal "protection or license to beg for one year to Alice, late the wife of John le Palmer, of Nottingham, who is building the bridge of Hethbeth." No doubt the lady's object in obtaining the license was that of invoking the assistance of the charitably disposed about the country, through the medium of bearers of begging letters.

All this time, of course, the local pontage dues were being levied. On January 1, 1315, a case came up at the borough court, when complaint was made against one William Metel, for arresting two cartloads of wood at Chapel Bar, the west entrance to the town, for pontage. Defendant pleaded that he suspected them to contain merchandise.

On the expiration of the previous license, on August 30, 1315, there was issued another "simple protection for two years for Alice, late the wife of John le Palmer, of Nottingham, building the bridge of Hethbeth." Moreover, on the same date she obtained an extension for three years of the pontage grant in 1311 for five years.

So far as appears on the surface it must be confessed that the foregoing documents allude only to Alice le Palmer superintending the expenditure of funds contributed by others. But the building of the bridge was her lifework, and we are fortunately able to show that she expended her wealth as well as her energies thereon, insomuch that she began to feel anxious as to her old age. Hence she took steps, the result of which remains on record in the following interesting note, dated February 1, 1317: "The king to the prior and convent of Thurgarton. Request that they will grant to Alice le Palmer, of Nottingham, by their letters patent, a suitable allowance for her maintenance in food and drink, to be received from their house for life, the king wishing to provide her with maintenance lest she should be brought to want on account of the expenditure of her goods about the construction of the bridge of Nottingham, upon which she has spent and still spends great sums for the common utility of all persons passing over the same, the king wishing that she may be animated to complete so desirable a work when she sees that she is sure of suitable maintenance for life."

In thus quartering the distinguished lady philanthropist on Thurgarton Priory, Edward II. exercised a privilege the crown appears to have claimed of providing for old servants at the expense of the monastic establishments. In the present case it yas evidently an "out-pension," for Alice le Palmer remained busy on the bridge many years longer.

When the same king granted an extension of "murage," or the right to take toll for the purpose of building the town wall, to the people of Nottingham on July 2, 1321, he inserted a stipulation that "custom is not to be taken of goods or merchandise whereof any custom is due in aid of the repair and amendment of the bridge of Hethbeth, and of another bridge between it and the land toward Gamston to be newly constructed, according to the king's grant to Alice le Palmer." Is it not possible in face of the preceding that the lady immortalized in "Lady Bay" is none other than this eminent bridge builder?

About six months later, on January 12, 1322, the king granted murage to the town of Nottingham for three years, with a clause that the customs granted to Alice le Palmer, "in aid of the construction of certain bridges near the aforesaid town," shall cease during the said three years, on account of the necessity of inclosing the said town. Herefrom we may perhaps infer that the Trent Bridge was now sufficiently complete for traffic, so that further operations might be postponed.

This year the chapel of St. James on the bridge was completed, the first two chaplains being instituted on November 23, 1322. The first chaplain of a chantry she had founded in Stapleford Church was instituted on the same date. Like other chantry founders, Alice le Palmer reserved to herself the rights of presentation so long as she lived, directing that after her death her rights should revert to the priory of Newstead, to which her ancestors had given Stapleford Church.

We next read of the bridge works on December 17, 1324, when the king addressed letters to the town authorities forbidding them to take further customs for murage by virtue of an unexpired license, "for the king has now granted to Alice le Palmer and Hugh de Stapleford that they may take certain customs upon things for sale coming to that town until the end of three years, in aid of the repair of the bridge of Hethbeth and the bridge of the new breach near it."

On April 30, 1327, the king granted a "protection" to Alice le Palmer for two years. No doubt this had to do with the raising of further money for the work of the bridge. On May 3, 1327, there was an extension for one year of the former grant of pontage to Alice le Palmer and Hugh de Stapleford for the repair of the bridge of Hethbeth, etc., and likewise a mandate to repair the same by view of two burgesses. Three days later, on May 6, 1327, the king directed the men of Nottingham to cease collecting murage during the corresponding period, "as the king has granted to Alice le Palmer that she may take such customs until Christmas next and for a year from then in aid of repairing the bridge of Hethbeth, and the king is unwilling that divers customs shall be taken in the town from one and the same thing."

We have an interesting item under the date of November 8, 1327, when there was a royal grant to Alice le Palmer, "in consideration of her great labors and expenses on the construction and repair of the bridge of Hethbeth, over the Trent by Nottingham, that she be quit from payment of the 20th, lately granted by Parliament, and of all taxations, aids, tallages, etc., while engaged on such work."

On January 6, 1328, a commission was dispatched to survey the Trent Bridge, etc., and "to audit the accounts of Alice le Palmer and Hugh de Stapleford, collectors of the pontage granted by the late king for the repair of the bridges, and to take inquisition as to the amount received and the amount expended." One would imagine that the report of the auditors was a favorable one, for on August 30, 1328, there was another extension for one year of the grant of pontage to the lady bridge builder and her brother under the supervision of two burgesses.

But at this period undercurrents were at work, for in a few months' time a change came o'er the scene. On May 10, 1329, a royal mandate was issued ordering Alice le Palmer to cease collecting pontage until otherwise ordered, "as the king learns by trustworthy testimony that said bridge is now repaired, and that William de Amyas, now mayor of Nottingham, intends to repair out of his own goods all bridges between Leen Bridge and Trent Bridge, and that he has begun, and that Alice has expended nothing upon the repair of the bridge of Hethbeth since Michaelmas last, although she has continued to levy the tolls."

This is the last we hear of Alice le Palmer and her devoted labors. We may reasonably assume that she was in her decline, which would account for the alleged decrease in her activity, for she was dead within two years of this time. If it be true, as stated above, that the bridge was then "repaired" or completed, she lived to enjoy the crowning triumph of fulfilling her lifework, though evidently without securing the gratitude of the contemporary city fathers. Her only monument to-day is represented by the two southernmost arches of the bridge she built, adjoining the Trent Bridge police station, and supporting the inclined approach to the Lovers' Walk. Her life of perpetual self-sacrifice is but roughly outlined by the records we have quoted of six centuries ago.

AN ALL STATIONS EXPRESS TRAIN.*

AN ingenious device for obviating the delay involved in the stopping of local trains at all stations, though there may be only a small number of passengers desirous of entering or leaving the train, has been devised by Prof. J. Brown, A.M.I.E.E., of Belfast, Ireland. The inventor described his device before the British Association, at their annual congress last year, and, in order to demonstrate his project more lucidly, constructed a small working model. By the courtesy of the inventor we are enabled to publish herewith diagrams of the scheme, specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT, and herewith reproduced for the first time.

In Prof. Brown's idea a through train is provided for every passenger from one station to another, and all anxiety or doubt about alighting at the wrong station, or being carried beyond the desired destination, is avoided. It must be pointed out, however, that the scheme can only be operated with the greatest success by electric motors. Steam locomotives are quite inapplicable to the project.

The accompanying diagram (Fig. 1) represents an endless railroad with coaches arranged ready for starting the day's work. The cars are of the vestibule type, so as to give a free passage right through the train. Each car has its own separate motor, and thus runs independently. A train consisting of, say, four coaches, starts from station *A*. As this train approaches station *B*, the car, *A*, standing there is started by the driver in charge of it, and sufficient speed is given to it to allow it to be picked up between stations *B* and *C* by the following train. This may seem difficult, but in reality there should be no more difficulty in picking up a car in steady motion than there is every day in running up gently to one at rest. It is merely a question of relative motion, and, with electric motors, the speed can be easily and quickly controlled. If necessary, an appropriately placed signal box would eliminate any possible risk at this point. As soon as car *A* has been picked up, the motorman of the train goes to its forward end and there takes control of the train, connection being made to the motors of all the other cars for that purpose; or the motorman of car *A* takes charge of the train, and the former motorman goes to the rear car ready to slip it.

In order to allow passengers for station *B* to alight, the train as it approaches *B* slips its last car, marked *B*, which is then brought to a standstill at station *B*. The same process is repeated at each station. The result is a through express car for every station. The passenger simply enters a car standing at the platform from which he departs. As soon as it is coupled to the train he looks for the car marked for his destination, and remains in it till it stops, when he can alight with ease. He may not find the proper car at once, but certainly a few stations before his destination. Two or more cars may be slipped or picked up, of course, if one is not enough.

Although here shown as applied to an endless railroad, the scheme is equally applicable to a railroad with termini. From an engineering point of view, several advantages accrue which may not be at first sight apparent, viz.: A much shorter station is required than in the usual method where the whole train has to be accommodated at every platform, and considerably less power would be required, since only a fraction of the train has to be stopped and started. The load would also be more constant; in fact, it would scarcely vary at all.

In the model there are two stations and the train is formed of two cars only. As these approach a station the car standing at the station is automatically

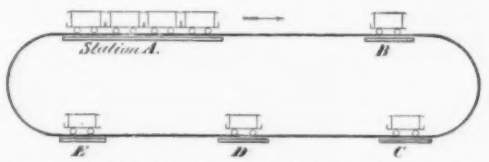


FIG. 1.—DIAGRAM OF AN ENDLESS RAILROAD WITH FIVE STATIONS.

started, to be immediately afterward picked up by, and coupled to, the running car following.

On the side of each car is a switch, *A*, through which the current passes to the motor through the contact stud, while the switch is in the position shown. Remembering that in the particular arrangement of cars and stations adopted in the model, the car after starting has first to pass one station as leading car and then to stop at the second one, the action of the switch will be clear. On approaching the first station a pin, *R*, engages with the lower one, *D*, of two guide pieces set at a proper distance on the entering side of the station. The switch which has hitherto been resting on the pin, *C*, in notch, *H*, is thereby changed to notch, *I*, but is not moved sufficiently to break contact. On approaching the second station, where this car is to stop, the pin, *R*, engages the upper guide piece, *E*, of the catch placed there, and the switch is thereby moved to notch, *K*, when contact is broken and the car stops at the station.

The same movement of this switch depresses the coupling lever, *F*, and detaches the car in front so as to allow it to proceed to pick up the car that has just left the station in advance.

Our car has now come to rest at the station awaiting an incoming train, on the approach of which it

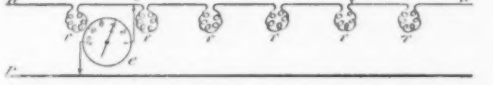


FIG. 2.—SCHEME OF SIGNAL ARRANGEMENTS.

must be started by bringing the switch back to notch, *H*.

The pin, *C*, which engages with these notches, *H*, *I*, and *K*, is carried on the end of a bell lever, *L*, actuated by a bent lever, *N*, with a projecting pin, *P*, so arranged that it may be pressed upward by a bar arranged on links, whose lower ends work on joints fixed on the track so as to rise parallel to itself when pulled up by a wire connected to a lever fixed on the line and worked by a pin on the incoming train. The movement of this lever pulls the pin, *C*, out of the notch and allows the switch, *A*, to drop back into the starting position, at the same time raising the coupler ready to engage with the spring catch on the overtaken car. The dropping back of the switch, *A*, is assisted by a spring.

It has been pointed out by railroad engineers that there is some element of risk of collision in this scheme, but this apprehension is more apparent than real, and in this connection one may well consider how easily and quickly properly equipped electric cars can be stopped on emergency.

In order to minimize risk still more the inventor

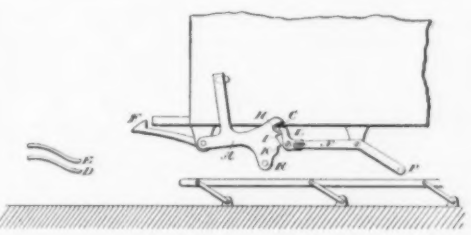


FIG. 3.—DIAGRAM OF THE LEADING END OF A CAR, SHOWING THE STARTING AND STOPPING MECHANISM.

has devised a simple means of protection by which the engineer in charge of the main train and the engineer in charge of the car about to be picked up can tell exactly the distance between the cars in their charge.

By the side of the line there are fixed a series of insulated contact strips, *R R'*, Fig. 2, each connected to the next one by a resistance coil of suitable proportion. By means of a sliding contact carried by the car in advance of the train, a point in this series of strips opposite the car wherever it may be, is put in contact with the positive terminal of the main elec-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

tric supply. A similar sliding contact carried by the main train connects a point opposite this train with the negative terminal.

In the event of an obstacle being present on the track the engineer of the car in advance would stop and such action would notify the engineer in charge of the following main train of danger ahead so that he could bring his train to a standstill. If, however, the engineer of the advance car did not happen to see the obstacle, the resulting accident would usually affect his car only, and, therefore, but a small fraction of the passengers on that section instead of a whole trainful.

THE VOLCANO OF COLIMA.*

By CHARLES RICHARDS DODGE.

THIS old fire mountain, in Mexico, which has been the subject of recent press dispatches on account of its alarming activity, is situated about 150 miles south of Guadalajara, and less than 40 miles from the Pacific coast. It has been "smoking" for nearly twenty-five years, though until this year it has not been regarded as menacing to the surrounding country. It is said by the scientists to be in the Mt. Pelé chain, and it is worthy of note that the first evidences of activity approaching violence were observed only a few days after the first Mt. Pelé outbreak. It soon returned to its normal condition, however, attracting no further attention until its recent violence called it again into public notice, and sent the denizens of the farms and near towns of the locality fleeing for their lives. The latest eruption occurred on August 2, which covered the mountain with lava and dense smoke, and was accompanied by loud detonations and rumblings.

Tuxpan is the present terminus of the railway line which extends southward from Guadalajara, distant from the last-named city about 120 miles. To reach the volcano from Tuxpan the old Spanish mule trail from Zapotlan, via Tonila, must be followed, the volcano lying northerly from Tonila, within about fifteen miles, across country, from this busy town. Both Tuxpan and Tonila were mentioned in the press dispatches, the latter city reported as having been abandoned. The city of Colima, which lies to the westward of Tonila about 20 miles, also felt the effects of the disturbance.

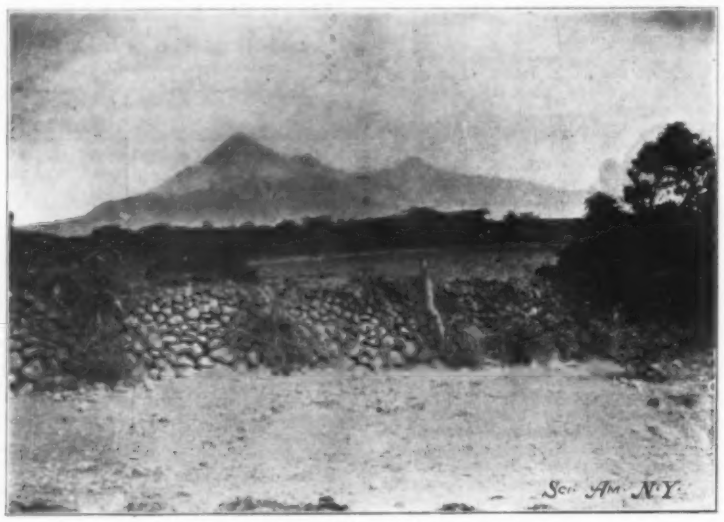
The writer spent three days in 1902 at the Hacienda La Joya, which lies just at the foot of Mt. Colima, and was afforded opportunity to climb the mountain, as far, at least, as was possible with safety. The mountain peak, as it rises above the timber line, is very precipitous, and is seamed and gullied from the erosion of ages, some of the seams being in reality deep valleys. The peak is difficult of ascent, and absolutely dangerous on account of the volleys of red-hot rock, weighing tons, which ever and anon are thrown from its crater, and which crash down the mountain side like an avalanche, and with the roar of a limited express train.

In normal times the eruptions occur at irregular intervals of thirty minutes to two hours. First is heard a dull rumbling sound which steadily increases in volume, while the crater is seen to send forth a cloud of smoke and steam. Then the masses of rock and loose stones rush down the paths of erosion, stirring up the dust on the way, these dust clouds appearing as a series of lesser eruptions as point after point is reached in the fall.

Mt. Colima is about the same elevation above sea level as Pike's Peak, or about 14,300 feet, the main peak of Colima rising above the surrounding country some 3,890 meters. The peak is absolutely bare of vegetation, appearing glistening white in the sunshine, against a deep blue sky, and on this account is a difficult subject for the camera. Our illustrations show the mountain with its chain of peaks, as seen from Tonila fifteen miles away, and from a point near the higher peak, two miles from timber line, the latter picture having been made during a slight eruption. To reach this point from Tonila we described nearly one-half of the arc of a circle.

There is no regular trail up the mountain. It is very steep in portions of the way, and is so rough a journey that the novice, on a mule, is liable frequently to find himself in hair-raising situations. But as a Colima mule can always be relied upon to "find a way," there is little danger in making the journey up to the timber line.

This is a region of earthquakes, and evidences of seismic disturbances in past time were noted in all the towns we passed through. Tonila was especially marked in this particular. The Mexican Central Railway is extending its line from Tuxpan to the City of Colima, following as nearly as possible, considering the deep cañons, or barrancas, of the region, the line of the old Spanish mule trail. On account of the recent activity of Mt. Colima a change in a portion of the route has been necessitated. The scenery of this entire region is wild and picturesque—the cañons formidable—that known as the Grand Barranca of Beltran being the most interesting. Here the sides seem to drop perpendicularly a thousand feet, the stone paved, zig-zag, mule trail which passes down and up—constructed in the days of Spanish occupancy with heavy retaining walls—showing engineering skill of high order, especially in an earthquake country, for the masonry seems as solid as when built in Cortes's time. One picture shows one of the many sharp turns in the trail, some of which have inclines so steep in places that the term "break-neck" is most applicable. Yet for centuries all of the merchandise, and the travel as well, that goes into this section of Mexico, is transported over this terrible trail upon the backs of pack animals, or horses. When the railroad is finished this trail will become a less important thoroughfare, and Mt. Colima will be more readily accessible to tourists.



MT. COLIMA FROM CITY OF TONILA.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

[Continued from SUPPLEMENT No. 1440, page 23078.]

VEGETABLE PHYSIOLOGY.*

By Prof. J. REYNOLDS GREEN, M. A., Sc. D., F. R. S.

ANOTHER worker of great eminence who has found similar conditions to exist in normal vegetation is Berthelot. He put blades of wheat and leaves of the hazel in flasks, displaced the air by hydrogen, and distilled. In the case of the wheat he heated the flask to 94 deg. C., in that of hazel he conducted the distillation by passing steam through the flask. In both he found the distillate contained alcohol. The quantity was not large, but still measurable; from 10 kilos of leaves he obtained 10 grammes of alcohol.

Mazé claims to have found alcohol under normal conditions in the stems and leaves of the vine.

Mazé finds, further, that the weight of a seedling of maize approximates at any moment during the early stages of germination to half that lost by the reserve store in the endosperm.

From his experiments, and those of the other authors alluded to, he concludes that alcohol is formed in the living cells of seeds at the expense of grape sugar by virtue of a normal diastasic process, which makes them approach yeast cells more closely than has been suggested by any of the experiments hitherto published.

We may inquire further how far the evidence points to the probability that the molecule of sugar is split up in that way into alcohol and carbon dioxide, and that the alcohol is the nutritive part of the sugar molecule. Certainly Mazé's experiments on the submerged seeds with the plumule exposed above the water are not inconsistent with that view. Duclaux has spoken more definitely still on this point, and has said that the alcohol formed becomes a true reserve material to be used for nutriment.

We have, however, further evidence that to some plants, at all events, alcohol is a food. Laborde has published some researches conducted upon a fungus, *Eurotiopsis gayoni*, which point unmistakably to this conclusion. He cultivated it in a solution containing only the mineral constituents of Rawlin's fluid and a certain percentage of alcohol, usually from 4 to 5 per cent. The plant grew well, forming little circular patches of mycelium, which enlarged radially as the growth progressed. The mycelium became very dense in the center of the patches, and the fungus evidently thrived well. As it grew, the alcohol slowly disappeared, the rate being about equal to that of sugar in a similar culture in which this substance replaced the alcohol. The mycelium in some experiments was cultivated quite from the spores. Eurotiopsis is a fungus which has the power of setting up alcoholic fermentation in saccharine solutions. When cultivated in these alcohol is accordingly produced, and subsequently used, but the growth of the mold is not so easy under these conditions as when the alcohol is supplied to it at the outset.

Duclaux has shown that in the case of another fungus, the well-known *Aspergillus niger*, though alcohol kills it while it is in course of germination from the spore, it can utilize for nutrition 6.8 per cent when it becomes adult, continuing to grow and putting out aerial hypæ. Eurotiopsis is more pronounced in its liking for alcohol, for it thrives in a mixture containing 10 per cent; even if submerged entirely it continues to grow and flourish in an 8 per cent solution.

The peculiarity relates only to ethyl alcohol; methyl alcohol will serve as a nutritive medium for only a little time, sufficient only for the commencing development of the spores into a mycelium and disappearing very slowly from the culture fluid. The higher alcohols, propyl, butyl, and amyl, not only give no nourishment, but are poisonous to spores. A very small trace of any of them can be used by the adult mold.

Laborde claims to have established as the result of his investigations that Eurotiopsis normally makes alcohol from the sugar to nourish itself with it, just as yeast makes invert sugar from cane sugar because it is the nutritive material it likes best. The enzymezymase is present in the fungus and plays the part of an alimentary enzyme. Its consumption lasts twice as long as that of a corresponding weight of glucose; it can serve twice as long for the nutrition of the same weight of plant.

These remarkable results lead us to the consideration of the mode in which the carbohydrates, and particularly the sugars, are assimilated by the plant. We have held the view that the sugar molecule is capable of entering with little if any alteration into that of protoplasm. We have found no direct evidence bearing upon its fate. It is possible to detect sugar in the axis of a plant till quite near its growing point. Then the reaction ceases to be obtainable, and we know that assimilation is taking place. But we have still to investigate the steps, no very easy problem to undertake. May it possibly be that it is the alcohol moiety of the sugar which the protoplasm takes up, part of the carbon dioxide evolved by the growing organ being an expression, not of respiration, but of a fermentation preliminary to assimilation?

But I feel I have dealt at sufficient length with this question. I pass, therefore, to consider briefly another nutrition problem of a rather different kind. The germination of seeds is a question that might be thought to have been fairly settled by the investigations of the latter half of the last century. We have come to the conception of the seed as fundamentally a young embyro lying quiescent within its testa, and provided with a store of nourishment deposited either within its own substance or lying round it in the tissues vaguely named endosperm or perisperm. The nourishment has been held to be practically ready for its use, needing only a certain amount of enzyme action to be applied to it to convert the food store from the reserve to the nutritive condition. We have recognized here starch,

MT. COLIMA, NORTHERLY PEAK FROM HACIENDA LA JOYA.

* Read before the British Association for the Advancement of Science.

proteids, and glucosides, and have ascertained that the embryo can furnish the appropriate enzymes for their digestion. Each reserve store has apparently been quite independent of the rest, and the embryo has had control of the whole.

Certain considerations, however, lead us to the view that for albuminous seeds at any rate this mode of looking at the matter is no longer satisfactory. We may first ask how far the embryo is the controlling factor in the digestion. Putting the matter in another

THE HOTEL, MAIN STREET, TONILA, COLIMA REGION.

form, is the influence of the parent plant lost when a stable store of food has been provided for the offspring, and does it leave its utilization entirely to the latter? Is the gametophyte prothallus merely to become a dead or inactive structure as soon as it has developed its young sporophyte, or may its influence extend for the longer period of germination? There are many reasons for thinking this is the case. Indeed, the view has been put forward by some observers at intervals for some years. Gris claimed to have shown it in 1864; but it was opposed by Sachs, who said that the enzymes which cause decompositions in the reserve materials are always formed in the young plant or embryo and are excreted by the latter into the endosperm. Some careful experiments on the point were conducted by Van Tieghem and were published by him in 1877. His work was carried out on the seeds of the castor-oil plant. He deprived the seeds of their embryos and exposed them for some weeks on damp moss to a temperature of 25 to 30 deg. C. After several days of this exposure, he found the isolated endosperms were growing considerably, and at the end of a month they had doubled their dimensions. In the interior of the cells he found the aleurone grains to be gradually dissolving, and the oily matter to be diminishing, though slowly. The dissolution extended throughout the mass of the endosperm, and was not especially prominent in the side that had been nearest to the cotyledons. He noted, too, that though starch did not normally appear in the germinating endosperm, under the condition of non-removal of the products of the decomposition, it did appear in the cells in the form of small grains, though not till after several days had elapsed. Van Tieghem also observed that the progress of the decompositions could be arrested and the endosperms made to reassume a quiescent condition, and that then the aleurone grains again became formed, though in less quantity than before.

In some experiments on Ricinus which I carried out in 1889, I found much the same sequence of events as Van Tieghem had described. The endosperm unquestionably became the seat of a renewed metabolism, in the course of which many interactions between the various reserve materials became noticeable. It was remarkable that the activity of this metabolism was much more pronounced when the embryo or parts of it were left in contact with the endosperms.

An observation of a similar character has been made by Haberlandt and by Brown and Morris in the case of the seeds of grasses. The conversion of the reserve cellulose of barley grains has been shown by these observers to be the result of the action of an enzyme *cytase*, which is secreted largely by the so-called aleurone layer, which is found surrounding the endosperm, immediately underneath the testa.

Recently my own work has been bearing on this question, particularly as regards the behavior of the seeds of Ricinus during germination. The reserves of this seed are mainly composed of oil and aleurone grains, hardly a trace of carbohydrates being present. At the onset of germination there is a remarkable appearance of both cane sugar and glucose, which increase as the oil diminishes. The old view advanced to explain this fact has been the transformation of the oil directly into the sugars or one of them, a theory which it was difficult to reconcile with the chemical possibilities of oil. I have found that side by side with the appearance of the sugar we have also the formation of a considerable quantity of lecithin, a fatty body containing nitrogen and phosphorus. The seed contains a comparatively large amount of phosphorus in the form of the well-known globoids of the aleurone grain, a double phosphate of calcium and magnesium. The occurrence of this body points to a considerable interaction of various substances existing in the seeds, the phosphorus apparently coming from the globoids and the nitrogen from the proteids. Instead, therefore, of the fat being transformed into sugar, it seems certain that a very considerable metabolism is set up, in which the very constituents of the endosperm interact very freely together. I am informed by Mr. Biffin, who has investigated the histological changes accompanying the germination, that the protoplasm of the endosperm cells appears to increase in amount very greatly during the early stages. The observations suggest a very vigorous resumption of metabolic activity by the cells of the endosperm, in the course of which the various reserves are brought into relation with the living substance of the cells and a number of new products are formed to minister to the nutrition of the growing embryo. The formation of the sugars may more probably be referred to the renewed activity of the protoplasm of the parent gametophyte than to a direct transformation of the fat under the influence of the embryo. Further researches upon a large variety of seeds appear necessary to give us a true idea of the chemical processes of germination. What now appears probable in the case of fatty seeds may prove to be true also in the case of those which have other varieties of reserve material.

I have already alluded to the problems concerning the electrical phenomena presented by the plant at rest and during activity. Very little work has so far been done in this direction, and our knowledge of the subject is materially less than that concerning similar phenomena in muscle and nerve. Still a beginning has been made, and we have observations on record due to Waller and to Bose which are of the greatest interest, not only because they show a great correspondence in behavior between animal and vegetable structures, but on account of their possible importance in determining the character of many of the metabolic processes and the forces at work in the tissues.

Some very striking results were only a few months ago published by Bose on the electric response in ordinary plants to mechanical stimulation. He arranged a piece of vegetable substance, such as the petiole of the horse-chestnut, or the root of a carrot or a radish, so that it was connected with a galvanometer by two non-polarizable electrodes. The uninjured tissue gave little or no evidence of the existence of electrical currents; but if a small area of its surface was killed by a burn or the application of a few drops of strong potash, a current was observed to flow in the stalk from the injured to the uninjured area, just as is the case in animal tissue. The potential difference in a typical experiment amounted to 0.12 volt. The tissue was then stimulated, either by tapping or by a torsion through a certain angle, and at once a negative variation or current of action was indicated, the potential difference being decreased by 0.026 volt. Very soon after the cessation of the stimulus, the tissue recovered and the current of rest flowed as before. Bose's investigations extended considerably beyond this point, and established a very close similarity in behavior between the vegetable substance and the nerves of animals. Summation effects were observed, and fatigue effects demonstrated, while it was definitely shown that the responses were physiological. They ceased entirely as soon as the piece of tissue was killed by heating.

This remarkable demonstration of similar electrical properties to those possessed by nerve strengthens very greatly the view of the conduction of stimuli in the plant by means of the protoplasmic threads which have been demonstrated by Gardiner and others to exist throughout the plant, uniting cell to cell into one coherent whole.

Much remains to be done in this field; indeed, not more than a beginning has been made. The electrical accompaniments to response to stimuli have been investigated by Burdon Sanderson in the case of Dionæa, but many other instances are still awaiting examination. The peculiar phenomena of electrotonus and their relation to stimulus have so far only been observed in animals.

These observations strengthen considerably the view of the identical nature of animal and vegetable protoplasm which has in recent years come into prominence, and which is receiving more and more support in all directions.

These electrical currents, following mechanical action, which no doubt is accompanied by chemical change, make us ask whether electrical phenomena do not in all probability accompany the slow chemical actions which we call metabolism. The view that electrical energy is concerned in the processes of photosynthesis, suggested in an earlier part of this address, is certainly not weakened by a consideration of these phenomena.

The probability of the transmission of stimuli through vegetable tissue along the protoplasmic threads, extending from cell to cell, has been supported during the last year or two by some remarkable observations claimed to have been made by Nemec on certain roots and other organs. He says he has succeeded in demonstrating a continuous fibrillar structure in the protoplasm of the cells, fibrils passing along it in a longitudinal direction and apparently connecting the protoplasm of a longitudinal series of cells into a conducting chain. These conducting strands extend between the sensitive region—e. g., the tip of the root—and the region which is growing, and which is caused by the stimulus to curve. Nemec says that these conducting strands can be made evident by the use of appropriate staining reagents. They vary in number and position, but appear to be confined to sensitive and motile organs.

It is clear that the matter cannot rest where it is. The statements made by Nemec call for investigation by both histological and physiological methods. It is possible that appropriate reagents may lead to the recognition of structure in what has been hitherto regarded as undifferentiated protoplasm.

Before concluding this address, I may call attention to the vast field opening up in connection with the pathology of plants. The work done by our predecessors has been more largely work on the morphological peculiarities of various fungi than upon the physiological changes which constitute pathology proper so called. It is only recently that attention has been given to the broad questions of disease in plants. Even now, however, certain advances have been made, and the direction of research is taking shape. In the

PRINCIPAL BUILDING, HACIENDA LA JOYA, AT FOOT OF MT. COLIMA.

ZIG-ZAG TRAIL IN THE GRAND BARRANCA OF BELTRAN, COLIMA.

science of pathology, little in recent years has been so fascinating as the question of immunity against the attacks of certain diseases, either hereditary or acquired. It has been bound up with the very large question of toxins and their attenuation, their opposites, the antitoxins and matters of a similar nature.

Great results have been obtained in human pathology, with which it is not for me to deal. I mention them here because we are face to face with the possibility of treating some of the diseases of plants in a similar way, and perhaps on the threshold of very far-reaching discoveries.

I may call attention to the discoveries of Ray and of Beauverie upon the general question of plant infection and especially upon a disease set up by a fungus known as *Botrytis cinerea*, which attacks grapes, begonias and other plants. The fungus exists in three forms, one of which is a harmless saprophyte, another a destructive parasite and a third intermediate between the two. The first is a very common fungus, developing on decaying plants and bearing ordinary gonidia or spores. The second is completely filamentous and bears no reproductive organs. It is produced when the air is heavily charged with moisture and the temperature high, conditions of common occurrence in forcing houses. The third is an attenuated form intermediate between the other two. It bears gonidia like those of the first, and in addition others which germinate without falling off the parent plant and elongate into long threads. Many plants can bear the invasion of this plant without suffering greatly, though it cannot be called harmless. It occurs chiefly when a high temperature is associated with a considerable amount of moisture in the air.

It is not difficult to cultivate this attenuated form of the Botrytis in sterilized soil. Beauverie describes one experiment made with it which is very striking. Damp earth was sterilized in a Petri dish of large surface, sown with spores of the Botrytis and kept at a temperature of about 16 deg. C. After three days, the surface of the dish was covered with a loose mycelium, which bore numerous gonidiophores. The fungus was allowed to grow for some time under these conditions, and the infected earth was then transferred to fresh pots in which were placed cuttings of begonias. The plants grew well and were not sensibly affected by the presence of the fungus in the substratum or in its surface. Placed subsequently in conditions which were eminently suitable to the development of the parasitic form, they resisted its action perfectly, though control plants which had not been cultivated in the ground infected by the attenuated form were killed very quickly. From their experiments the authors claim to have shown that the form of *Botrytis cinerea* intermediate between the gonidial and the sterile form can make plants immune to the attacks of the latter.

Researches of a somewhat kindred nature dealing with the infection of particular plants by specific fungi have been communicated recently to this section by Prof. Marshall Ward in his paper read last year on the Bromes and their brown rust. They brought to light many very important facts connected with the question of adaptive parasitism and immunity. Few questions in vegetable physiology can compare in economic importance with these when we think of their possible development in relation to agriculture.

I have now somewhat hurriedly surveyed certain parts of the field of vegetable physiology. It has been impossible in an address like this to do more than indicate what seem to me some of the more important problems awaiting investigation. May we hope that all such work will be vigorously conducted, but that the conclusions reached will be scrutinized with the greatest care and subjected to repeated examination? Great hindrances to the advance of the science resulted from dogmatic assertions made by eminent men in the past, their personal influence having led to their conclusions, not altogether accurate, being nevertheless almost universally accepted. Many years subsequently these conclusions have needed re-examination, the result being the destruction of a whole fabric that had been reared upon this unworthy foundation. I may close, as I began, by an appeal to the younger school of botanists to take some of this work in hand, and by assiduous and critical experiments and observation to contribute to the solution of the problems pressing upon us in this field.

MANUFACTURE AND EMPLOYMENT OF GAS FROM HEAVY OIL IN GERMANY.*

In 1814 John Taylor prepared for the first time oil-gas from vegetable fatty matters. He took out in England a patent for a process which was tried commercially, in several cities of the United Kingdom, especially in Hull and Liverpool, but by reason of the high price of the raw materials required in this manufacture, the gas of John Taylor could not sustain competition with coal gas, and the plants were soon completely transformed. In Germany, the first factory for the manufacture of oil gas was established, by Knoblauch & Schile, at Frankfort-on-the-Main, in 1828. About 1830 the vegetable oils were replaced with American resins, which were much less expensive, and it is due to this change that the factory at Frankfort has survived similar establishments in England.

In certain cities, as Cologne, Wesel, and Hanau, oil gas was compelled to yield the field to coal gas almost as soon as it appeared. The sole reason for this change was also the high price of the raw materials. Evidently, oil gas could not be utilized for public lighting, until it could be extracted from a current product of lower price. This point was successfully reached in Germany, in 1850, by obtaining coal tars in the crude state.

The progress of the industry of petroleum gas is chiefly due to Hirzel. He constructed the first factories and gradually improved the mechanical apparatus. He was assisted in his task by the general development of German industry, which at that time displayed new activity.

At present, the only materials employed in the manufacture of oil gas are mineral oils, coal tars, petroleum and its derivations. These products are formed, for the most part, of saturated or incomplete carbides of the fatty series. They also contain some members of the benzene series, as well as small quantities of oxygen, nitrogen, and sulphurated products. I shall show further on the possible influences of these different bodies on gasification.

This operation is effected in cast iron or steel retorts heated externally. Clay retorts are utterly unsuited for this purpose, and in Germany at least are not thus employed. The retorts may occupy a vertical, horizontal or inclined position in the furnace, but, whatever be the arrangement, the gas-producing apparatus may be divided into two classes. The first includes those into which the oil enters in a state of vapor and is decomposed under the action of the heat radiating from the sides of the retort, in order to produce a second, non-condensable gas, which may be stored and utilized for illumination. In the second class the oil is introduced in the liquid state and the warm sides of the retort effect directly the vaporization. As a type of the first class, the Young & Bell retort, employed in the Peebles process, may be mentioned. It is a cylindrical body, 68.5 centimeters in diameter and 2.74 meters long. The Diworkovitch retort represents the principal type of the second class. In Germany, the first type of apparatus is represented by the Wagner retort, a modification of the Young retort. The second type is represented by the Schumann & Küchler retort, in which vaporization and gasification occur almost simultaneously by direct contact with the hot sides. Finally, these two systems are found combined in the Pintsch and Hirzel & Suckow apparatus, employed in Germany, and in those of Keith, Patterson, and Pope, in England.

On leaving these vessels, the gas is conducted into a water purifier, where it gives up a portion of its condensable constituents; then into a condenser, where it deposits the tarry matters with which it is still burdened. The apparatus is similar to that employed in the production of coal gas. In some systems no water purifier is attached, in others it is placed immediately before the condenser; but generally it is united to the latter, serving as a support. Before passing into the reservoir the gas should be freed from the sulphurous products which it contains. For this purpose, it is passed through a series of purifiers identical with those employed for ordinary gas. The purifying mixture is also the same. Contrary to the course pursued in the case of coal gas, it is unnecessary to proceed to an extraction of carbonic acid and ammonia. It is also superfluous to employ an aspirator, since the gas traverses the different pieces of apparatus from its own pressure.

Thus the apparatus for refining is much more simple than in the industry of coal gas. This advantage does not stand alone, because, by reason also of its superior illuminating power, oil gas only requires pipes of small diameter and reservoirs of restricted capacity. The production is, therefore, economical in various respects. The temperature of the retorts varies from 800 deg. to 1,000 deg. C.; in the Peebles system the range is from 500 deg. to 600 deg. C. This last method employs as a condenser a set of pipes somewhat horizontally inclined, which serve also for bringing the oil into the decomposing retorts.

The operation of an ordinary oil gas factory is usually simple. The color of the retorts indicates the propitious moment for the introduction of oil; and the color of the gases, which should be yellow or clear brown, determines whether the gasification is well accomplished. Other secondary observations, such as the proportion of tar deposited and the odor of the gases obtained, are sufficient to insure successful working of the apparatus. In large establishments these simple observations give place to a strict inspection by means of photometric measurements on the final gas.

In normal manufacture, and by a pressure of 40 to 80 millimeters in the retorts, 100 kilogrammes of oil furnish 50 to 60 meters of gas, whose illuminating power, varying with the yield, averages that of eleven to twelve candles; in coal gas, the illuminating power diminishes as the yield of gas increases, without an absolute ratio between these two factors. For photometric measurements, a consumption of 35 liters per hour is taken as a base, although 150 liters is taken for coal gas. But the Direction of the Prussian railways has approved a consumption of 33 liters per hour, without reducing proportionally the exigible illuminating power.

In most cases, a defective output or a somewhat feeble illuminating power is caused by an imperfect operation of the apparatus, whether the introduction of the oil is too rapid, too slow, or simply irregular. If, on the contrary, the machinery is proved to be operated perfectly, there may be reason for inspecting the quality of the oil employed. Certain oils present anomalies in respect to gasification; but, above all, the good working of the apparatus must be assured. I can affirm from my own personal knowledge that while two factories were employing the same oil, the one secured from it about 55 meters, the other only 47 meters of gas. The smaller output was of higher illuminating power, but still not proportional.

The yield obtained by the Peebles system is superior to that of all others. It is difficult to give exact figures on this subject, because in England, where this system is employed, the gas is not burned alone. It is employed exclusively in the carbonization of ordinary coal gas. Burned alone, moreover, it disengages considerable smoke. It may, however, be admitted as accurate, that 100 kilogrammes of oil distilled in the Peebles apparatus would furnish on the average 65 meters of gas of about 18 candles illuminating power.

When this gas is to be employed in illuminating railway cars, it is condensed in the factory itself into reservoirs, under a pressure of 12 atmospheres. From these reservoirs it is dischaged, either into the general reservoir of each car, under a pressure of 10 atmospheres, or into the special reservoir of each compartment, at the pressure of 6 atmospheres. It is then conducted to each burner at ordinary pressure.

In the gasification of oil in the retorts, the oil vapors, under the action of the radiating heat, are converted into gaseous hydrocarbides of very low boiling point. These hydrocarbides belong for the most part to the fatty series. At the same time, by contact with the superheated sides of the retort, a portion of the hydrocarbons formed are polymerized so as to produce aromatic carbides. In the first case, the vapors of oil, containing complex members of the methane series and of the olefines of elevated boiling points, will yield simple methanic carbides and some gaseous members of the olefine series, such as ethylene, propylene, and acetylene. Then, again, the saturated hydrocarbides will be separated into olefines and methane.

In the second case, on contact with the overheated sides of the retort, the olefines, produced in the beginning, or originally existing in the oil, will undergo a polymerization which will convert them into aromatic carbides, as benzine, or its methyl derivatives (toluene, xylene, etc.), or even naphthaline. And, in fact, a portion of these bodies are found again in the tars condensed on their escape from the retorts.

These carbides communicate to oil gas considerable illuminating power, but their solubility in this gas, already quite feeble, is further decreased by cooling and especially by compression, to such an extent that they are for the most part deposited. To retain them in the oil gas, some diluting substance, such as air, oxygen, or water gas, is added. In the manufacture of oil gas it is necessary to take into account how it is to be employed, whether burned alone or mixed with coal gas, or to be employed in carbureting water gas.

An oil gas having an illuminating power of ten to eleven candles for a consumption of 33 liters per hour has the following average composition:

Carbonic acid	1.0	per cent
Oxygen	0.5	"
Heavy hydrocarbides	33.0	"
Carbon oxide	2.5	"
Hydrogen	15	"
Methane	46	"
Nitrogen	2.0	"

For comparison it may be useful to give that of ordinary coal gas:

Carbonic acid	1.5	per cent
Oxygen	1.4	"
Heavy hydrocarbides	3.0	"
Carbon oxide	8.0	"
Hydrogen	48.7	"
Methane	33.4	"
Nitrogen	4.0	"

It is seen that coal gas contains ten times less heavy hydrocarbides than oil gas, and three times more hydrogen.

The calorific power of oil gas is comprised between 10,000 and 12,000 calories; that of coal gas between 4,000 and 5,000 calories. The illuminating power of the first is triple or quadruple that of the second.

The percentage of hydrocarbons and of methane in oil gas and its illuminating power diminish as its temperature of decomposition is raised. On the contrary, it contains much more hydrogen.

Lewes has gasified a schist oil at a very low and also at a very high temperature. In the first case, he obtained 40 meters of gas and 80 in the second. The first gas contained 80 per cent of heavy hydrocarbides, the second only 5.3 per cent. The ratio of the amounts of hydrogen was as 18.89 : 68.47 per cent; that of the quantities of methane, 41.30 : 23.22 per cent.

If the oil gas contains a small quantity of acid compounds, its illuminating power does not seem to be influenced by them, but it is affected greatly, if the amount is much increased.

The limit of percentage of acid products to be allowed in oil gas is a subject of discussion between producers and consumers. In Germany, the syndicate of oil producers has fixed this limit at three volumes per cent, and as this figure would evidently vary according to the method of analysis employed, it has been decided to insert in contracts that generally used in the factories of Saxony.

The nitrogenized compounds, such as pyridine and quinoline, likewise decrease the yield of gas. Almost all the mineral oils of Saxony made use of in the production of gas are comparatively free from these compounds, by reason of the treatment with sulphuric acid which they undergo, with a view to the manufacture of paraffine.

The sulphurous compounds may be mentioned as products wholly injurious. There is no economical industrial process which will completely free the mineral oils from them. The percentage of sulphur in crude oils varies from 0.5 to 1.5 per cent. About one-quarter of this passes over in the gas. The surplus remains in the tars and in the coke. According to the temperature of the operation, the sulphur in the gas is recovered under different chemical forms. The principal of these are: hydrogen sulphide, which may be absorbed by the purifying mixtures; carbon sulphide and the sulphureted derivatives of the hydrocarbides, which will remain in the purified gas.

Generally, oil gas, after refinement, still retains 0.25 to 0.30 gramme of sulphur per cubic meter. This percentage increases with the elevation of the temperature of gasification, and in this case, the proportion of sulphur in the state of hydrogen sulphide will always be less. By gasifying at a temperature sufficiently elevated, a crude gas might be produced containing only traces of hydrogen sulphide, so that the final percentage of sulphur in the refined gas would be considerably above the average. These conditions exist also in the manufacture of coal gas.

In England the proportion of sulphur in illuminating gas is subject to strict regulation. It must not exceed 0.43 gramme per cubic meter. Oil gas manufactured under normal conditions always satisfies this requirement.

In the treatment described above, and by employing the most improved apparatus, 50 to 60 per cent of the oil is collected in the state of gas; 30 per cent passes over in the tar, either without decomposition, or in the form of liquid or solid aromatic hydrocarbides, which are collected in the washer or condenser; 4 to 6 per cent of the oil remains in the retort in the form of coke, or is deposited in the pipes as soot.

Numerous researches have been made for the purpose of reducing to a minimum the percentage of liquid products resulting from gasification. Taylor endeavored from the beginning to effect this purpose by

* From the German of M. W. Schethauer, in the Journal für Gasbeleuchtung.

operating at a very high temperature, but this method was attended with difficulties of another sort. Later Hilary attempted to accomplish the object by joining to the retort a reflux condenser, intended to gather into the gasifying apparatus liquid parts and the condensed tars. This attempt, as well as those of Dinsmore & Krämer, was unsuccessful. The invention of the so-called "Peebles" process effected industrially, for the first time, the integral conversion of the oil into gas and solid residue.

The Peebles method consists in a fractional distillation of the oil and a washing of the gases by means of fresh oil, based on the principle of counter-current. It must be remembered that the oil contains quite a large number of very diverse products, boiling at very different temperatures. The gasification is conducted at a low temperature in such a manner that only a part of the oil is converted into gaseous products by the radiating heat of the retort. These gaseous products, as they escape from the retort, are washed by the fresh oil, which itself yields up to them its most volatile constituents. The liquid part descends to the retort, where, in its turn, it undergoes gasification.

In this process each hydrocarbide, whose gasification necessitates a temperature superior to that of the retort, is therefore gasified by fractions, and this fractionation is pursued in such a manner that at the end the oil is divided into two products: gas and coke. The proportion of coke is approximately 25 per cent of the weight of the oil. The coke forms an excellent combustible. Further, this process has the great advantage of furnishing a gas which yields no other condensation product, neither by cold nor by compression. That obtained by the other processes contains, on the contrary, some dissolved bodies in the gaseous state, which are deposited under certain conditions, while lowering as a consequence, the illuminating power of the mixture.

The Peebles gas owes its illuminating power, for the most part, to ethylene and its homologues, as well as to acetylene. These hydrocarbides exist in the gaseous state under pressure of 12 atmospheres. The gas is used for ameliorating the quality of coal gas. In Germany no factory has made use of this system. Generally the manufacture of oil gas is associated with that of coal gas, and the retorts of the former are heated by the spent gases of the latter. The manufacture is so regulated that the gas delivered to consumers contains one-sixth of oil gas.

The method employed by me yields a gas which, under the pressure of 12 atmospheres, abandons a small fraction of its hydrocarbides in the form of minute liquid drops. On an average, 100 meters of this gas thus furnish 8 to 10 kilogrammes of liquid hydrocarbides, and the loss of illuminating power resulting from it approaches 25 per cent. The condensed liquid presents the following average composition:

Benzine	70	per cent
Toluene	15	"
Higher homologues	5	"
Homologues of ethylene	10	"

This mixture may easily be fractionated for the extraction of benzine and other useful products. The Prussian railway administration, which manufactures its own oil gas, extracts thus annually considerable quantities of benzine. Besides the employment of the latter in the manufacture of aniline, it may be used for carburizing coal gas. Krämer has also proposed a system of illumination based on the employment of 2 parts of alcohol and 1 part of crude benzine. This mixture may be employed in lamps where American petroleum is now burned, while the principal disadvantage of Russian petroleum is that they require lamps of a special pattern.

The tar of oil gas collected in the German factories has a density of 0.95 per cent. In appearance and odor it is very similar to coal-tar. Besides the aromatic carbides such as benzine and toluene and small quantities of naphthaline and anthracene, it also contains considerable quantities of hydrocarbides of the fatty series. Its composition is variable, depending on the manner of conducting the operation. Usually the proportion of aromatic carbides will be greater when the temperature of gasification is the more elevated. If the temperature is low, a part of the oil is found in the tar unchanged.

The distillation of this tar furnishes about 15 per cent of an oil, of which the greater part boils at 200 deg. C., and which is designated by the name of *crude benzol*. It may be employed like the portion of Peebles gas condensable under pressure. The residue of this distillation is employed like tar, either alone or mixed with other coal tars.

Oil gas, like ordinary coal gas, may be used directly for lighting; its illuminating power is four times as great. With an hourly consumption of 60 liters, an illuminating power of 60 candles is obtained in an Auer (Welsbach) burner. These burners are already employed with oil gas in lighting the streets and public buildings of Nietleben and Weissenfels.

The lighting of railway trains with oil gas has made considerable progress. In Germany more than 30,000 cars and 3,000 locomotives are lighted by this agent.

The Prussian Railway Company alone consumes annually 4,000,000 meters of this gas.

As to acetylene, its manipulation is not yet exempt from danger. The gas manufactured by the Pintsch company is a mixture of 80 per cent of oil gas and 20 per cent of acetylene. The illuminating power of this gas compressed is raised from 6.7 to 20.2 candles for an hourly consumption. It is true that, in this case, an oil gas of moderate illuminating power is employed. With a gas of good quality, the addition of 20 per cent of acetylene would only double the illuminating power. This mixture does not appear to be attended with danger, and may be utilized in the same burners as ordinary oil gas.

According to the statements of the Prussian Railway Company, the oil gas costs 92 centimes (17 cents) per meter. This price covers manufacture, the apparatus for storing and employment, as well as cost of all the material.

In ordinary plants, without reference to sinking fund, the cost of the manufacture of a meter of oil gas comes to 30 or 33 centimes (5.4 or 5.9 cents). For small plants, the cost would be about 36 centimes (6.48 cents). Of this net cost, about 60 per cent must be set down for the oil itself, and 40 per cent for expenses of manufacture and the material.

SEEKING THE MAGNETIC POLE.

THE latest expedition which has set out for the Arctic regions is to engage in a comparatively unique investigation. Amundsen's purpose is very different from Peary's or Nansen's. He will not try, except incidentally, to enlarge the world's information of coast contours, and will probably have little to tell of rock formations, fossils, or existing animal or vegetable species in the field of his exploration. If successful, though, the Norwegian will make discoveries which should prove of great value to navigators in Northern seas and to those mathematicians who prepare for the sailor and land surveyor tables of correction for compass readings.

It has been known for centuries that the needle does not point exactly northward over all the Northern Hemisphere. When Greely's party was at Lady Franklin Bay, twenty years or more ago, its compasses were directed about ten degrees south of westward. From similar observations it has been perceived that the magnetic and geographical poles do not coincide. Indeed, while there is only one geographical North Pole, there are indications of two magnetic North Poles, the chief one being situated near the northern coast of the American continent or in the archipelago beyond it. The minor pole is in Siberia. These facts alone would cause no inconvenience, perhaps, were it not that the amount of departure from the true north is forever changing. One theory which has been advanced to account for this phenomenon and kindred mysteries is that the Siberian pole has shifted its position or that its intensity has altered, thus causing a readjustment of its pull in competition with the American pole. Somehow the conviction that the latter has moved is less strongly entertained, although no one is in a position to make a positive statement.

Although experts in terrestrial magnetism have been able to make fairly trustworthy guesses about the American magnetic pole, only one previous effort has been made to find it by visitation. The first two expeditions to this part of the world by Sir John Ross were prompted by a desire to find the "northwest passage" to India. His third venture, which kept him nearly four years in the Arctic region, beginning with 1829, was a quest for the magnetic pole. His ship was frozen in and abandoned in the Gulf of Boothia. Subsequently, with boats, he worked his way out to Lancaster Sound, where whalers rescued him. Upon his return to England he reported that his dipping magnets occupied a vertical position when he reached latitude 70:07 and longitude 96:43 west of Greenwich. He was then upon the peninsula of Boothia Felix. Neumayer, the leading German authority in such matters, and the late Charles A. Schott, of the United States Coast and Geodetic Survey, located the pole in 1890, by computation only, from two to four degrees eastward, in substantially the same latitude as Ross. Owing to their lack of agreement and to the absence of any corroboration, of course those conjectures have little value.

Amundsen purposes to determine the question with precision by the only method upon which reliance can be placed. Though he may depart from Ross' programme in certain particulars, he will follow the earlier explorer's route up to a certain point. He intends to leave Baffin's Bay by way of Lancaster Sound and to push westward along the seventy-third parallel of latitude. When his work is finished he may be able to continue in the same general direction as far as Behring Strait and then come southward. The essential features of the enterprise are, however, that he will make magnetic and meteorological observations, and has food enough to last three or four years.

THE PRESERVATION OF BOOKS IN HOT CLIMATES.

By FRANK BROWNE, Government Analyst, Hongkong.

BOOKS in hot climates quickly deteriorate unless carefully seen after. There are three destructive agencies which have to be guarded against: (1) damp, (2) a small black insect, (3) cockroaches.

(1) Books which are kept in a damp atmosphere deteriorate on account of molds and fungi which grow rapidly when the conditions are favorable. Books are best kept on open, airy, well-lighted shelves. When there has been a prolonged spell of moist weather their covers should be wiped, and they should be placed in the sun or before a fire for a few hours. Damp also causes the bindings and leaves of some books to separate.

(2) A small black insect, one-eighth of an inch long, and a sixteenth of an inch broad, somewhat resembling a beetle, is very destructive, and books will be found, if left untouched, after a few months to have numerous holes in the covers and leaves sufficiently large for the animal to pass through. If this insect be allowed plenty of time for its ravages it will make so many holes that bindings originally strong can be easily torn in pieces. All damage may be prevented by coating the covers of books with the varnish described under (3). When books are found to contain the insects they should be well rapped and put into the sun before varnishing.

(3) The appearance of a fine binding may be destroyed in a single night by cockroaches. The lettering of the binding may, in two or three days, be completely obliterated.

The following varnish has been found to prevent effectually the ravages of cockroaches and of all insects that feed upon books:

Dammar resin	2 oz.
Mastic	2 oz.
Canada balsam	1 oz.
Creosote	½ oz.
Spirit of wine	20 fl. oz.

Macerate with occasional shaking for a few days if wanted at once, but for a longer time when possible, as a better varnish will result after a maceration of several months.

Where it is necessary to keep books or paper of any description in boxes, cupboards, or closed bookcases, some naphthalene balls or camphor should be always present with them. If camphor be used it is best to wrap it in paper, otherwise it volatilizes more quickly than is necessary. In dry weather the doors of closed bookcases should be left open occasionally, as a damp still atmosphere is most favorable for deterioration.

THE ROMAN FORUM.

DURING the last few weeks, says the correspondent of the Morning Post, great progress has been made by the Director of the Roman Forum, Commendatore Boni, in this immeasurable field for exploration. Considerable light has been thrown on the subterranean galleries connected with the games held in the time of Cæsar in the Forum. It is now clear that there were twelve elevators, each of which was worked by four men ensconced in chambers adjoining the apertures, also twelve in number, through which the elevators were hoisted into the open Forum above. Signor Boni is confident that there was some means of communicating with all the twelve chambers simultaneously from the room in which the director of the games sat. There was probably some kind of a speaking tube or simple telephone, by the use of which at a given signal the twelve elevators could be made suddenly and simultaneously to rise from the bowels of the earth to the open Forum, and to deposit there the parties of gladiators ready for the fray. Signor Boni has had made a model of one of these elevators, instructive traces of which are still imbedded in the galleries underground. Nine of the elevators have still to be freed from equestrian statues which were set up above them at a later period, and this task must of necessity take some time. The foundations of these statues are in themselves so far interesting that they afford additional proof, if such were needed, of the callous manner in which any sort of material, whether valuable statue or portion of the Lapis Niger or some other remnant of interesting history, was utilized in later mediæval times as substructure.

Signor Boni has also just discovered the complete square basement of the Janus Medius, which used to serve as the meeting-place for the old Roman bankers. It occupies precisely the spot assigned to it by the ancient writers, near the Arch of Janus in front of the Tabernæ Argentariæ. This, too, has been greatly spoiled by the work of the builders of the middle ages, who sank wells and built latrinæ about it. In one of the wells have been found quantities of remains of animals, such as sheeps' jaws and goats' horns, and also fragments of pottery. In the middle of the road flanking the Basilica Julia he has also discovered ritual graves rectangular in shape, with a length of 4 and a breadth of 2 Roman feet, and divided by a space of not more than 10 Roman feet. In them he found a quantity of vases in the shape of chalices. He believes them to be augurial graves used for expiatory libations after contamination with human blood.

While exploring under the substructure of the Heroon of Romulus he came on a nearly complete prison composed of narrow passages leading to diminutive vaulted cells with tesselated pavements, and having a very strong sub-pavement of large, heavy flags of travertine to render the escape of prisoners impossible. As a further precaution perimetral walls of blocks of tuff lined with bricks were built outside. At the foot of the Palatine Hill, behind the Sacrarium of Juturna and the Temple of Castor and Pollux, Signor Boni has discovered the remains of an old Imperial palace, consisting of a building with a large hall adorned all round with niches, and with a vestibule, transformed at a later date into a Christian sepulcher, used as late as the eighth century. The walls and columns are ornamented with frescoes finished in the eighth century, and covered with Greek inscriptions. In the central portion of the building is to be seen a painted representation of Pope Paul I., who was pontifex during the ten years succeeding 737.

In the neighborhood there are visible traces of four different layers of plaster, each decorated with paintings. On the top of one layer of plaster, which has a red surface, is another portraying a representation of the Madonna and Child, similar to those seen in the mosaics of the time of Teodorico. This painting covers in its turn another layer which shows traces of two angels painted in the sixth century. Above these, and painted during the middle of the eighth century, is a stratum of plaster showing figures of saints with nimbus in yellow and ascetic-looking faces. On the right is a series of paintings showing the figure of Pope Zacharias, the crucifixion of Christ, and the figure of Theodotus, uncle of Pope Paul I., who is represented as offering a model of the church, while in the Latin text adjoining he proclaims himself to be the "assisting advocate of Santa Maria Antica." This was the name of the Christian church which existed until the ninth century within the walls of the imperial palace. Sixteen centuries, says Signor Boni, separate the tombs of the church of Santa Maria Antica from the Sepulcretum of the pre-Romolean Septimontium, which is now being rapidly explored.

Since I last wrote on the subject of these prehistoric tombs several new graves have been found by Signor Boni. One of them was being removed during my interview with Signor Boni, and it contained a very interesting black jar, which was tenderly placed on the table in the little museum. It was incrusted with damp earth, and has yet to be cleaned and put together. Another contained a skeleton, the head of which had been distorted by the subsidence of some blocks of tuff, with which the grave had been lined. In the grave of another skeleton, that of a child, several toys were found, and in another a lovely fibula of transparent amber hollowed out underneath in order to allow of the light entering more easily for the sake of still greater transparency.

Reopening of the Port of Mazatlan.—Consul Louis Kaiser writes from Mazatlan, Mexico, June 16, 1903, that that port has been declared open by President Diaz. All restrictions on traffic have now been removed.

A COMBINED EXHAUST VALVE AND IGNITER FOR GASOLINE MOTORS.

Our illustrations show a novel combined exhaust valve and igniter now fitted to the motors of the Duryea gasoline automobiles, as well as one of the Duryea cars that is being used successfully in far-off Japan.

The exhaust valve, *a*, is carried by and seated in a cast-iron chamber, *b*, screwed into the wall of the engine. The valve stem, *d*, is screwed into a holder, *E*, carrying a roller, *f*, which is struck at the proper time by the cam, *g*, mounted on the cam shaft in the usual manner. A lock nut secures the adjustment of the valve stem, *d*, in the holder, *e*, at any desired point. A scissor spring, *h*, bearing against the cast-iron chamber, *b*, at one end and against the lock nut at the other, keeps the exhaust valve closed unless lifted by the cam, *g*. The stem, *d*, of the exhaust valve is hollow throughout its length, and a smaller stem, *i*, terminating in the curved arm inside the firing chamber of the engine, passes through the hollow valve stem, which serves as a bearing or journal for it. This stem also projects beyond the valve stem into the center of the roller holder, *E*, where it is provided with a clamp, *j*, and a hammer, *l*, connected together by a coiled spring. The clamp, *j*, is fastened to the igniter stem, *i*, by a set screw, and the hammer, *l*, is mounted loosely upon it. An upwardly projecting lug on clamp, *j*, fits in a notch in hammer, *l*, and the coiled spring crowds the lug against one side of the notch, as shown in Fig. 1. Under the point of the hammer is a flat plate, *m*, pivoted, as shown, in a bracket forming one of the slide caps. On the operating cam, *g*, is a roller, *n*, which at the proper time moves the plate, *m*, outward, causing it to rotate the hammer slightly and coil the spring tighter, which, in turn, forces the sparker stem, *i*, to rock until the point comes in contact with the insulated anvil or plug, *o*, projecting into the firing chamber. Further movement of hammer, *l*, is allowed for by the wide notch in same, and serves only to press the sparking points tighter together. When the point of the hammer slips off the plate, the hammer acquires a rapid velocity under the reaction of the spring, and strikes the clamp, *j*, a sharp blow, which knocks the point on the stem, *i*, out of contact, making a quick, sharp break of the electrical connection, and thus producing a large, hot spark in the firing chamber. After the burned gases have done their work, the exhaust valve is lifted by the cam, thus raising the hammer, *l*, out of the path of movement of the plate, *m*, and permitting the latter to move back into its original position. The seating of the exhaust valve brings the sparker parts into position again. The plate, *m*, is pivoted in an eccentric journal in its bracket, which eccentric permits adjustment for earlier or later firing, while the spring on the stem of the plate insures rapid return to position at high speeds. The insulated point, *o*, is a ring of nickel screwed onto a steel stud having a flange about midway of its length. Mica washers larger than the flange are placed on this steel stud, and clamped by union nut, *p*, to the body of the plug which, in turn, is screwed into the wall of the combustion space. Either the plug may be removed as an entirety, or the union nut, *p*, can be removed, which permits withdrawing the insulated part for cleaning or inspection. This arrangement places the mica washers well away from oil and soot, and thus insures long service without loss of insulating qualities. The outer end of the insulated rod is not threaded, but is slightly reduced; and on this fits a spring clip, which, by its elasticity, tends to bind itself tightly. It may be quickly detached, but will never rattle loose, and always has a good contact. Its construction is evident from the photographs. It is likewise split at its opposite end

FIG. 1.—EXHAUST VALVE AND IGNITER AS ATTACHED TO MOTOR.

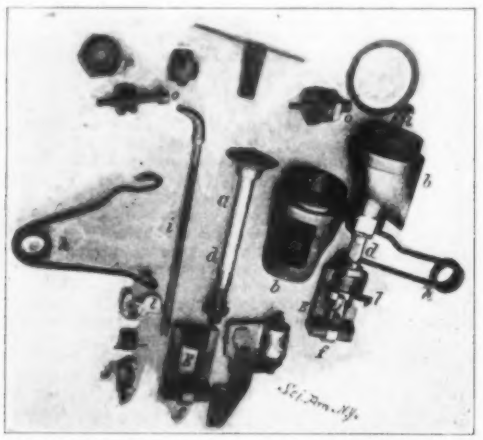


FIG. 2.—PARTS OF EXHAUST VALVE AND IGNITER.

THE DURYEA COMBINED EXHAUST VALVE AND IGNITER.

and pinches the wire supplying the current. The sparker parts are placed directly in front of the inlet valve, where the incoming gases not only cool them, but where the mixture is most likely to be free from the burned gases retained in the combustion space. The inlet valve is quite light, and its motion is controlled by a stop adjusted by the throttle, so that a great or little opening of the inlet valve may be permitted as desired, and thus much or little power secured from the engine. This stop is likewise provided with a spring slightly stiffer than the inlet valve spring, which may be caused to force the inlet valve off its seat, thus relieving compression when desired. If, however, an explosion occurs, the elasticity of this spring is such as to permit the valve to be forced shut, and no loss of power or back firing results.

One of the illustrations represents a Duryea surrey recently shipped to Japan. The photograph was taken in front of a Japanese temple, with the Lord High Priest in the carriage. This vehicle has a triple cylinder motor of ten horse power, placed under the operator's seat, thus concealing the mechanism, while permitting perfect accessibility by removing the cushions and front panel of the operator's seat. The motor and transmission gear give two speeds forward and a reverse, and are a unit, being on the same shaft, very compactly placed and well housed from exposure to dirt. Large bearings, large clutch surfaces, and ample power are provided; the triple cylinders being 4½ x 4½. The wheels are 30 inches front and 36 inches rear, with 3-inch tires. The rear axle is 1⅝ inch diameter and extends through both wheels, one wheel being driven by a sleeve over one end of the axle. The most marked feature is the control, which is largely located in the single vertical lever at the center of the operator's seat. The four necessary controlling functions, viz., steering, throttling, speed changing, and braking, have been made as simple as possible, and three of them are operated by the single lever, while the brake is operated by the foot. Since throttling and steering comprise the major part of controlling the motor vehicle, this arrangement is quite satisfactory, a sidewise motion of the lever steering, and twisting the handle throttling. When desired, an up or down motion puts in either the high or low gear. The reverse is operated by a heel pedal. The long wheel base and low center of gravity contribute to carriage-like comfort.

A DURYEA SURREY IN OLD JAPAN.

THE PRODUCTION OF BRONZE COLORS.*

By DR. EMMELL.

COPPER and zinc are original materials with which the production of bronze colors has to be started, and since this industry found its origin centuries ago in Nuremberg-Furth, in Germany, the same materials have been used for the purpose. Gold bronze is nothing else but fine powdered brass, and brass is an alloy of copper and zinc, obtained by the well-known methods universally in use. The copper-zinc alloy is made into finger-thick rods, and then hammered by means of heavy mechanical hammers into thin leaves, which have to be annealed frequently, to avoid becoming too brittle during the manipulation. When the leaves have been hammered quite thin, these have to be bathed in lye and cleaned. The production from the melting of the material for the alloy to the pounding to bronze powder is a very slow process, and causes the cost of production to be so high.

The unceasing pressure of competition has had its influence on the prices of bronze, and for a long time brass scraps have been used for the purpose, and, on the whole, the mixture cannot be described as having suffered by this change. . . .

The copper used in the bronze color production is nearly all made by means of electrolytical methods, and for this reason the electrolytical works use the cupriferous pyrites (i.e., the quantities out of which the sulphur has been burned), with sodium sulphate (after such has been pounded into small fragments and roasted), when a copper sulphate is formed, and this is lixiviated in suitable tanks. The cupriferous roasted material can easily be obtained from sulphuric acid works. Only Spanish pyrites should be used, as these only contain the needed quantity of sulphur.

It is different with the preparation of the zinc which has to be used. The zinc supply rests mainly in the hands of the old brigade, who produce it from zinc-containing materials, and not after the new electrolytic method, which is best described as the dry process.

The zinc obtained by the old method contains, in spite of refining (as has been proved by Schnabel), iron, lead, cadmium, copper, antimony, if only in small quantities, but sufficient for certain alloys, which, under given circumstances, can seriously affect the quality and the product for which it is used. The zinc produced by the electrolytical method becomes through the electrolytical separation of the impurities of the metal a pure zinc metal, and the latest methods make the production of a chlor-zinc solution quite easy.

It is natural that the excellence of a bronze or a metal alloy (brass) should depend on the purity of the metals employed. But for this one thing is still wanting, and that is the electrolytical production of metallic solid zinc by means of an effective and cheap method. It must be stated that prominent manufacturers have spent much time and money to find a proper solution of this problem. Had the attempts been successful to make electrolytic, solid blocks of zinc, it would have been possible to supply the bronze-color industry with a chemically-pure zinc metal. The electrolytic production of zinc has been successful, as a whole, but not for our purpose, because the soluble and insoluble anodes in the electrolytes produce, in spite of all technical care and foresight, a sponge-like, very difficultly refoundable metal. . . .

To obtain, on the one hand, pure metals as material, and on the other hand to avoid the wearisome and expensive hammer and annealing process, the electrolytic production of brass-leaves out of an electrolytic alloy comes very near. In this case, the chlor-zinc solution would have to be purified with the copper sulphate solution in certain concentrations and combinations, and, according to the desired color or tinge of the brass-leaves, a calculation would have to be made to find the quantities needed for the several alloys. These quantities would have to be fixed for both materials of the electrolytes, which could be added to from time to time as the electrolysis requires it. As the physical properties of both metals are very different, the mixed electrolytes would have to be worked with an alternating current to produce a mixture of metallic zinc and copper in the form of thin leaves, which could at once, without any other preparation, be used for pulverization. This process would only need an addition of suitable fatty substances. The unrippled surface of the leaves as produced by the purified and hammered metal can be obtained without difficulty. Technical reasons point out that in this way a more fiery and, in grain, softer material would be obtained. The experiments hitherto made on a small scale with mixed electrolytes have been accompanied by some difficulties, but they were successful, and point to an increased use of the method in future.

Several years ago experiments in this direction were made, but it is not quite clear if the same ideas

*From Oils, Colors and Drysalteries.

served at the time as a basis, or if other methods were intended. As the matter is of great industrial importance, further experiments should be made, and, without doubt, improvements in this line could easily be shown. A careful calculation as to cost should at first now be the deciding factor, because, at the present time, only the copper employed is of electrolytical origin, and the old kind of zinc metal has still to be used; but, as the future is sure to bring an improvement in this direction, the present calculation is sure to be materially altered. In some factories the new method has already been introduced and found of advantage; but to make it the real and needed success, it requires the support of the whole bronze-color industry, which will reap the benefit of all the advances and improvements.

Look, for instance, at the chemical industry, as an example. Means were found to open new ways, and the ceaseless work and energy have produced numerous, often unexpected, innovations and inventions which have made the chemical industry one of the foremost in the whole world. Look at the coal-tar industry, which, at its beginning, had not the means it possesses now; but enterprise has brought success.

The road to other experiments may be pointed out which undoubtedly will also lead to the reward to which it is entitled. The molten alloy of copper and zinc is led alternately through a thin spout in a constructed battery of tanks, which have been filled with a sufficient quantity of water. To maintain a constantly equal temperature of the water lower than the temperature of the air, it is necessary to cool the tanks by means of ice. Each tank receives only a few pounds of molten metal. There are already patents in existence for pouring the molten alloy into water, but without regard to the temperature of the water, when the metal forms into little balls, which have to be rolled to leaves and must be annealed several times during the process.

When metal of, say, 1,000 deg. C. and water of 5 to 7 deg. C. come into contact, the metal is cooled so suddenly that it is blown into fine metal dust, when it can be pulverized or pounded without hammering or annealing, giving an excellent bronze powder without much work.

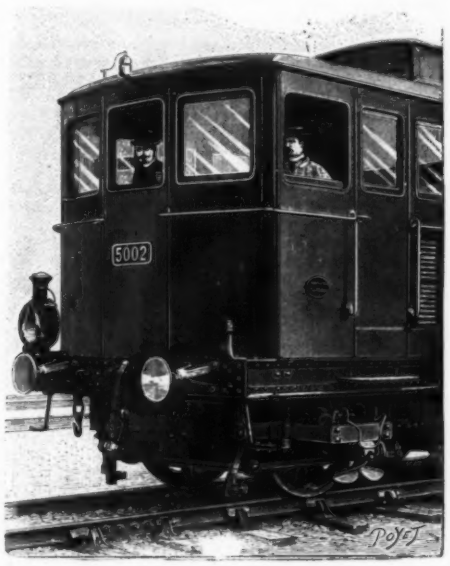


FIG. 2.—FRONT OF THE LOCOMOTIVE OF THE RAILWAY LINE OF THE WEST.

ELECTRIC LOCOMOTIVES ON FRENCH RAILWAYS.

THE Paris-Orleans Railway Company has just decided upon the prolongation of its electric line as far as Jurisy, and the trains of its trunk line, which now change locomotives at the Austerlitz station, will, after the work is finished, be hauled electrically for a distance of about fifteen miles, starting from the Quai d'Orsay. In order to assure this new service, it will naturally be necessary for the company to increase the number of its electric locomotives. The new ones will, like the old ones, be provided with apparatus of American manufacture, mounted by the Thomson-Houston Company, the establishment that installed the entire equipment of the Quai d'Orsay-Quai d'Austerlitz line.

The Railway Company of the West employed electric locomotives up to last year for coupling at the Champ de Mars station to trains coming from Saint-Lazare and running to the Invalides. This operation of changing engines, which retarded the service, having been done away with, the electric locomotives are now employed for the traction of a certain number of the trains of the Versailles line.

In Figs. 1, 2, and 3 are shown the locomotives, or electric "locomotors," of the Orleans and West lines, which are of very different aspect and bear no resemblance to the engines that we are accustomed to see at the head of ordinary trains. Like steam locomotives, however, they are the result of the application of the same principle, which consists in the running of a train by a single vehicle and one that is designed for traction solely. With the use of the steam engine, this is obligatory because it is necessary to carry a boiler that may be of large size, and because the motive parts must be situated in proximity to the production of steam. With electricity, the case is no longer the same. It is easy to understand the inconveniences that are presented by the grouping of the motors of a train upon one vehicle designed exclusively for traction, that is to say, upon one on the principle of the tractor.

In terminal stations situated in the center of cities, where land is costly, the locomotive has the drawback of requiring supplementary tracks for its passage from one end to the other of the train, or of the terminal loops. The operation to be performed, moreover, is lengthy and incompatible with a quick service. In addition, the space occupied by the locomotive diminishes the effective length of the platforms. For metropolitan lines, preference is given to the use: (1) of isolated motor cars that do not possess the character of locomotives, since they carry passengers; (2), of, for more important traffic, these same motor cars coupled to one or two trailers, which, unfortunately, are no better adapted for reversal of direction than trains that are hauled by locomotives; (3) or, often, of trains with two motor cars, one at the head and the other at the rear, and capable of running in both directions.

Trains drawn by locomotives, trains consisting of a motor car coupled to a trailer, and trains having a motor car at the front and rear have one serious drawback, and that is of not readily lending themselves to a modification in length according to the necessities of the traffic. In fact, it is advantageous to have a tractor normally haul only the load for which it was calculated, and so the conditions become defective when, at the time of a special rush, such load has to be increased. This consideration is very important for all metropolitan and suburban lines, the traffic of which greatly varies according to the season, the day of the week, and even the hour of the day.

One of the most serious questions for city and suburban lines, as well as for those of which we shall speak further along, is that of adhesion. We know that the adhesive weight of a train, or the weight supported by the driving axles, limits the effective force that the latter are capable of yielding. If such force is greater than about seven times the adhesive weight, the wheels will revolve without moving forward. The result is that the motors of a train must be heavily weighted. Since, in electric traction, there is no longer any necessity of carrying with the trains the generating apparatus (boiler, etc.) which in steam traction constitutes a natural adhesive weight, it becomes necessary to supercharge the tractor, artificial-

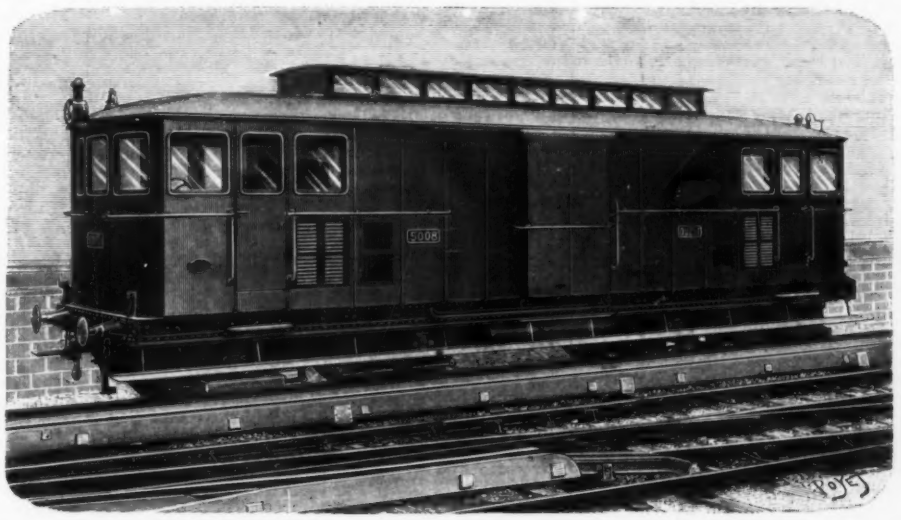


FIG. 3.—COMBINED LOCOMOTIVE AND BAGGAGE CAR OF THE RAILWAY OF THE WEST.

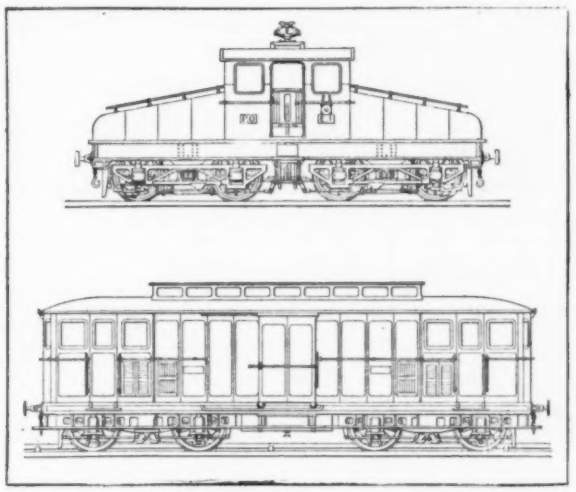


FIG. 4.—DIAGRAM OF THE TWO LOCOMOTIVES.

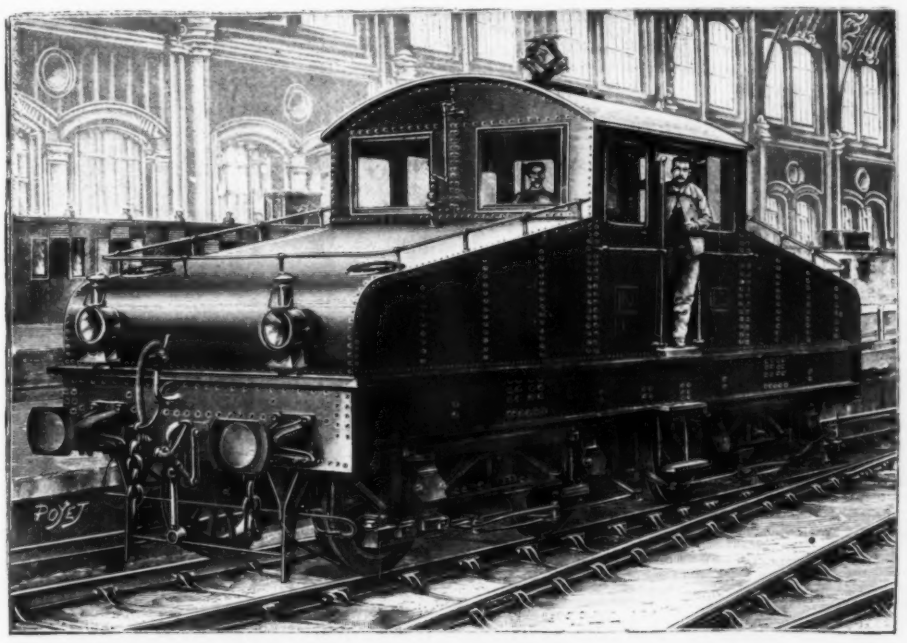


FIG. 1.—THE ELECTRIC LOCOMOTIVE OF THE ORLEANS LINE.

ly, the total weight of which, diminished by the weight of the motors themselves, is an absolutely useless element of the train that involves a superfluous expense for its movement. It is therefore very natural that it should be preferred to place the motors under the passenger cars and thus utilize the weight of the latter and that of the passengers themselves for adhesion.

Trains without locomotives, but with a limited number of motor cars (one motor car coupled to trailers, or one at the front and one at the rear) do not permit of an entirely adequate adhesion when the trains are somewhat lengthy. So, what are called "multiple unit" trains, consisting of motor cars of absolutely any number whatever, characterized by the subjection of the apparatus that regulates the running of the motors upon each car individually to one general control, are coming more and more into use. Such trains have the advantage that they can be elongated when need be, or divided into two parts, or permit of the union of several into one on branch lines. At all events, they assure the same relative adhesion and the same power of motors per ton of train, since each element (or "unit") subtracted or added possesses its individual motor.

When it is a question solely of maintaining an acquired speed, the force requisite at every instant upon a level track and at a reduced speed, is, as is well known, relatively small. Theoretically, a movable body, started at a certain velocity, keeps up its motion of itself. In practice, it suffices to overcome the resistances to the rolling of the movable parts and the resistances opposed by the air. But if it is a question of creating speed, the case is entirely different, and a train requires a force proportional to the acceleration of such speed at every instant, that is to say, to the rapidity with which the normal running speed must be reached.

Upon metropolitan and suburban lines on which the stations are very close together, it is necessary, in order to prevent too great a loss of time due to the numerous stoppages, that the startings shall be effected very rapidly, and this explains the importance of adhesion for such exploitations. When the service by isolated automotor car is impossible, there are therefore employed: (1) trains with one motor car coupled to one or two trailers, which, however, are far from proving perfect solutions of the problem; (2) trains with two motor cars, one in front and the other at the rear, which also have their inconveniences; (3) or, finally, the system of multiple-unit trains. All such applications are much preferable to the use of trains hauled by ordinary locomotives.

Adhesion is again a question of the utmost importance for mountain lines, and it is for this reason that trains with multiple motor cars are preferred to those hauled by locomotives. They will be still further preferred for high speed lines, the experiments at Zossen having demonstrated the necessity of rendering all the axles driving ones.

The electric locomotive, therefore, seems to be absolutely condemned. Nevertheless, there are special cases in which the use of it is necessary, and the company of the West, and that of Orleans, had to solve a problem which could admit of no other solution than that of locomotive trains.

For the Orleans line, multiple motor car trains were out of the question, since the same train, hauled electrically from Quai d'Orsay to Place Valkubert, must, continuing its journey from this place, be transported by means of a steam locomotive. The locomotives of the line of the West have been devised for the traction of trains which, run electrically as far as Versailles, have to continue their route beyond it. They are employed in the suburban service only while awaiting the installation of the Chantiers station. We shall now briefly describe the types adopted by the two companies.

The current is taken up by a shoe sliding upon a lateral rail. Both types are mounted upon two trucks, each of which is provided with two springs. Each of the axles carries a motor of about 200 horse power. The motors are grouped invariably in pairs. The two groups are either in series or in parallel (full speed), and in their circuit, for starting and slowing down, are interposed resistances placed in boxes in the interior of the locomotives. The groupings of the circuits are effected by controllers, which are of quite a large size by reason of the strong current upon which they have to act. The motors of the Orleans line are American, of Thomson-Houston make. The locomotives of the line of the West, ten in number, are of two kinds, one of which has its motors mounted directly upon the axles, while the other is provided with gearing. There are three types of motors, the Thomson, Westinghouse, and Brown. The following are the characteristics of the two locomotives:

	West.	Orleans.
Total weight in tons	40 to 50	45
Length between buffers	42.6 ft.	34.75 ft.
Length between the axes of the trucks	23 ft.	16 ft.
Length between the axes of the axles	8 ft.	7.8 ft.
Number of motors	4	4
Number of controllers	2	1

The Orleans locomotives have but one motorman's cab, whence the occupant can see in all directions, and consequently run a train in both directions. The locomotives of the line of the West are, on the contrary, provided with two cabs—one for each direction in which the locomotive can run. Moreover, the locomotive of the West is provided in the center with a baggage compartment. It is not a vehicle entirely useless for traffic; it is a "baggage-car tractor." Such an arrangement does not appear to be extremely advantageous. In fact, according to the regulations as to the exploitation of railways, there must be a baggage-car at the rear of each train and one between the tractor and the first passenger car. These two baggage-cars suffice for the ordinary service, and the supplementary baggage compartment of the locomotive therefore becomes useless. The arrangement has the drawback of doubling the number of all the controlling apparatus.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

ENGINEERING NOTES.

On the Michigan Central Railroad, with 559 automatic signals, on 279 miles of road, the number of signal failures and train delays reported by the signal inspectors in the month of April was 31. The causes of these failures and delays were: Wet track, 4; broken rail, 1; lightning, 2; broken wire, 9; defect in relay, 1; failure of battery, 1; train in block, 1; other causes, 12. No false clear indications were reported. The average number of failures and delays for the four months preceding April was 19¼ each month.

It is proposed to hold an international exhibition in Manchester in 1905, and a preliminary working committee has already been appointed to take such steps as are considered necessary to ascertain the views of those likely to be interested in such a project. Two large and important exhibitions have been held at Manchester, viz., the Art Treasures in 1857, and the Royal Jubilee in 1887, both eminently successful, the latter being visited by 4,750,000 people, and yielding a net profit of over £50,000.

An inquiry has recently been made into the hours of female labor in Prussia, says the Berlin correspondent of the Times. The inquiry was made on October 1, 1902, and the factory inspectors now report that out of 390,000 women over sixteen years of age, 50,000 work for nine hours or less, and 200,000 work from nine to ten hours. Roughly, 140,000 women have a working day of more than ten to eleven hours. Over 60 per cent, therefore, work for ten hours or less. The conditions are most favorable in Berlin and Charlottenburg, where 66,000 workmen are employed for ten hours and less, and only 7,000 for more than ten to eleven hours.

The following information was summarized from various trade publications by the Bureau of Statistics: July 14 will see a railroad opened that is destined to do much for Scandinavian and English commerce and manufactures. Because the Baltic freezes, England's capitalists, wanting a supply of Swedish iron all the year round, have built a railroad from the mines, or iron-ore deposits, near Gellivare to Ofoten, on the coast of Norway. King Oscar of Sweden has consented to be present at the opening. For some time ore has been carried on a branch of the road to the Norwegian fiord from the mines or hills of Kirunavara and Narwik. Gellivare is an inland town of Sweden, nearly 50 miles north of the Arctic Circle. It is the center of vast forests and iron-filled hills. It is much nearer to Lulea, a port on the Gulf of Bothnia, whither, were it not for the long winters, its wood and iron would naturally go; but the Gulf of Bothnia, a bay of the Baltic, is closed to navigation for four or five months of each year. Russia's tireless efforts to get a better seaport than St. Petersburg is due to a similar cause. That city is on the Gulf of Finland, another arm of the Baltic that is closed with ice for five months in each year. English enterprise and English capital have done and are destined to do much in the development of Scandinavia's resources—particularly those helpful to English industries. The long and severe winters of the Arctic are being conquered and the Baltic winter defied. Even the tourist is to be taken in summer time, at least, into the wild regions over which the road passes. It is singular that somewhat similar conditions confront England in her Labrador iron regions and that a proposition has been made to overcome them in the same way by building a road to the mines. It is thought that it might be made to pay in more ways than one; for Labrador (parts of it, at least), like vast regions in Scandinavia, is covered with primeval forests—woods rich in the very best kind of building material. With the price of wood rapidly rising, it may pay Labrador to put railroads far into her forests.

The following is a résumé of an article published in the Frankfurter Zeitung, June 29: Lord Rosebery wrote the London County Council, submitting a plan for the establishment of a school in London like the famous technical high school at Charlottenburg, near Berlin. In his letter, Lord Rosebery says it is almost a shame that capable, ambitious English boys, who are striving to obtain a complete technical training, are forced to visit American or German universities. Many English industries have suffered—some of them very seriously—and some are still suffering because England failed to provide advanced instruction in the technical trades, sciences, etc., or to provide means for doing the research work that is done so successfully by the Germans.

The most complete example of such instruction, according to Lord Rosebery, is, perhaps, the technical high school at Charlottenburg—which the empire has to thank for a large part of the industrial success attained since 1870-71. Because of Berlin's and Charlottenburg's better methods of preparing young men for their life work, young Londoners and other English boys that come up to London to look for positions find them already filled by Germans. Here one has the cause of the German clerk's ubiquity. He is better prepared than is the English boy for all kinds of work, particularly along lines that call for technical training. Lord Rosebery indicated a desire, in his letter to the county council, to contribute liberally to such a school. He adds the names Wemher, Veit & Co. This firm, as well as others, is willing to expend large sums to secure such a school. A beginning is to be made by buying four acres in Kensington for $1,000,000. Upon this, buildings to cost $1,500,000 are to be erected. The only hitch in the good work is the necessity of getting $100,000 per year to support the school. The main purpose of Lord Rosebery's letter is to get the county council to guarantee the money. A committee or body of directors has been organized, with Lord Rosebery at its head. Among the members are the Duke of Devonshire, Lord Balfour, Julius Wemher, and the vice-chancellor and president of the University of London. With such men behind the movement it ought to succeed. Of the great need of technical, industrial, and industrial-art education England is at last fully aware. It has been preached for so long and by so many able advocates that its development can only be a question of a very short time.

ELECTRICAL NOTES.

With the aid of a subsidy from the municipality of Berlin, the amount of which has not yet been fixed, the Berlin Overhead and Underground Electric Railway Company has at last complied with the proposal of the municipal authorities that it should construct an underground extension of the system from the Potsdamer Platz right through the town, from the eastern to the western center, where it will for the present terminate.

In a new German process of producing metallic calcium by electrolysis, the calcium is obtained by electrolysis of fused calcium chloride, in a furnace with carbon walls as anode and a small rod of iron inserted through an insulated bottom, as cathode. The main point in the process is that the electrolysis is conducted at a temperature below the fusing point of the calcium. The latter, therefore, separates on the anode in a spongy mass, containing about 50 per cent of metallic calcium. This spongy mass is compressed, while still in the electrolyte, with tongs or in any other suitable manner, and removed from the electrolyte. It presents a metallic fracture and contains nearly 90 per cent of metallic calcium.

Some interesting experiments are in course of prosecution on the Berlin elevated electric railway. Complaints have been made concerning the noise made by the cars traveling over the elevated structure. The first experiment consisted in inserting three layers of felt between the rails and the wooden cross ties on which they were laid. This was inadequate, however, although it gave some improvement. Next, hollow iron girders filled with loose sand were substituted for the wooden sleepers; this also was partially effective, but not entirely so. The rails were then laid on long longitudinal sleepers with cushions of lead under them. Finally, the car wheels have been lined with wood, so as to break the continuity of the path for vibrations through metal. These experimental remedies are still on trial, but no conclusions concerning them have been announced.

In a paper read before the recent engineering conference in London Mr. Monkhouse pointed out the greater simplicity of the single-phase system as compared with the polyphase in power transmission and railway work; the chief features which he brought out are well known in the art. He concluded with the statement that the advantages of transmission of power by single-phase alternating current are so apparent that it only remains for a suitable motor to be produced which will give as good results, both as to regulation and efficiency, as are given by the best continuous-current motors, to insure the system being used for long-distance power transmission in the future. In the discussion following the paper, Alexander Siemens pointed out that the whole question of the transmission and distribution of single-phase alternating current hinged on the last difficulty, as the complicated devices necessary for starting single-phase motors and bringing them up to synchronism, did away with all the advantages gained beforehand.

In the discussion which took place on Lieut.-Col. Crompton's paper on electric motor carriages, read before the Engineering Conference recently, Mr. T. E. Gatehouse gave some interesting data respecting a new secondary battery, which would appear to possess the features which are desirable for this class of work. The Elieson cell is a pure Planté cell, and as constructed consists of five plates, two positive and three negative, weighing altogether 16 lbs. The total weight of cell, complete with box and acid, is 22 lbs., and it has a capacity of 100 ampere-hours at a five hours' duration of discharge. The plate consists of a central conductor consisting of a lead tube placed vertically in the center of the plate. From this on either side branch out thin laminæ of lead. These laminæ are alternately corrugated and plain. The inner ends—i.e., next the tube—of all the laminæ are burned together, and the half-plate so formed is burned onto the tube. The outer ends of the laminæ are thus left perfectly free to expand, both horizontally and vertically, in the plane of the plate. The construction of the positive and negative plates is identical, the only difference being in the thickness.

In the Elek. Zeit. an abstract of a report made to the Swedish government is published on the advisability of changing the motive power on the Swedish government railways from steam to electricity and thus enable the government to make use of the water powers and turf deposits of the country, instead of importing coal. Continuous-current transmission is excluded on account of the length of the railroad system and the small density of population. Polyphase currents with high-voltage transmission and transformer sub-stations also appear unsuitable. The single-phase alternating-current systems are in their present form also unsuitable for application on the Swedish railways. A calculation of costs was made on the supposition that the whole system, of 4,332 kilometers, was operated by electricity. Power was to be furnished by 22 power stations, 17 at waterfalls and 5 at peat bogs. These stations are to furnish single-phase alternating current of 40,000 volts and 25 periods, which is stepped down by transformers along the line to 7,500 volts for the contact cable, the rails to be used as return circuit. The locomotives are furnished with rotary transformers. The speed regulation of the motors is effected by changing the direct-current voltage at the rotary transformer. For passenger and freight trains the locomotives must have 700 horse power. The cost of the whole undertaking, including copper, poles, rail connectors, protective devices, and installation of the lines, is calculated to average about $2,716 per kilometer. The necessary power is calculated at 120,000 horse power, of which 80,400 would be furnished by water power and 21,600 by burning peat. A calculation shows that the expenses for electric motive power would be higher than for steam, but for reasons of political economy the Swedish government has given its assent to the change to electric traction. Previously, however, the installations in other countries are to be exhaustively studied and an experimental line is to be installed, to work out a suitable system.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Cotton-Goods Trade of Manchuria.—Consul H. B. Miller reports from Niuchwang, China, May 28, 1903, in regard to the cotton-goods trade of Manchuria. He sends samples* of goods now being introduced into that market for the first time, and says that they are known as Ningpo native cloth and are being manufactured and handled entirely by Chinese. The company began operations about two years ago, and at present seems to be having considerable prosperity. Their place of production is at Ningpo, China, and vicinity. The cloth is made from yarns spun in Chinese mills and from imported yarns. The yarns are colored before being woven and the colors are fast and durable. The cloth is made in pieces 20 yards long and 25 inches wide. The price of these goods at Ningpo is $3 Mexican ($1.85 United States) per piece. The company furnishes the yarns to the villagers and pays them by the foot for weaving. The work is done on handlooms in the homes by women and children, whose earnings are only a few cents per day. The goods are meeting with much favor and the enterprise seems to have a most successful future. This is another substantial evidence of what China is doing in the development of cotton-goods manufacturing. These samples are evidence of their ability to produce a splendid quality of goods.

The great market for cotton goods in Manchuria is attracting the earnest attention of Russian manufacturers at Moscow. They are seeking to capture a good share of the 21,000,000 taels ($12,180,000) worth of the cotton-goods trade that annually comes through this port and are offering most tempting inducements to merchants here to go to Moscow to purchase their supplies.

The consul further says:

Referring to my dispatch No. 157 of February 21, 1903, to the minister at Peking, in which I mentioned that a Russian agent had taken a number of merchants to Moscow to make a contract for the importation of drills imitating American products, I have to report the return of these merchants to Niuchwang. The contract, they report, fell through because the drills were not quite up to the standard of the American in quality. The color was too yellow and the parties could not fulfill their promises as to price. They therefore made no purchase of drills, but purchased other goods to the amount of 60,000 taels ($34,000), such as watches, groceries, cambrics, prints, etc.

The "imitation" venture has not been a success, and it is questionable whether the enterprise will be continued.

The completion of the Siberian Railway has certainly brought a new factor into the great cotton-goods trade of North China, and American manufacturers must be alive to the situation and adjust their business arrangements to meet these new conditions if they wish to hold their trade.

The Volunteer Fleet, heavily subsidized by the Russian government, is bringing Russian goods to North China at very low freight rates, and these goods are being entered at Port Arthur and Dalny without paying any customs duties; besides, the port charges for ships are nominal and there are no pilot charges. American goods go first to Shanghai, where customs duties and port charges, storage, and handling are paid, and are then reshipped to Niuchwang, where freight, pilotage, port, and handling charges are again paid.

These goods could be delivered direct to Dalny as cheaply as to Shanghai, if not more cheaply, and thence be distributed to Tientsin and other points in North China.

Unless it is considered useless to endeavor to hold and extend American trade in Manchuria, it is high time interested Americans were giving more earnest attention to the industrial and commercial changes now taking place in this part of the world.

Recently an official of the Department of Commerce of Russia took a prominent native banker and four young Chinese merchants with him to Russia to interest them in purchasing Russian goods.

Russia is trying to secure the trade and commerce of Manchuria. She has many traveling salesmen in this part of the world hunting for business.

A Chinaman by the name of Mang has made three trips to Russia over the Siberian Railway to purchase Russian goods, mostly cotton fabrics. He has been quite successful, and is now organizing a much larger company of Chinese to continue the enterprise.

I inclose a small line of samples of the goods he is successfully bringing from Moscow. By making these trips he has the advantage of selection from a great variety. In this class of goods the Chinese are especially desirous of variety. They do not care to purchase the same pattern twice. They want new designs each year. This is contrary to the general impression concerning Chinese taste, but it is very important. It is a knowledge of this and a catering to it that aids the Japanese in extending their trade with the Chinese. This characteristic is only true of figured or printed goods. With plain goods the reverse is true. The Chinese become accustomed to a certain "chop," or brand, and it is most difficult to get them to change.

While the Russian goods referred to are generally more expensive than American, they are making their way largely because they are fast in colors.

Contracts are made for these goods delivered at Dalny or Port Arthur, where they are entered without duty. They are brought by the subsidized Russian Volunteer Fleet.

I am advised that this fleet, bringing goods from Russia to Vladivostock, Port Arthur, and Dalny, consists of fourteen steamers, with a tonnage of 38,481 tons, and is annually subsidized to the amount of 600,000 rubles ($309,000).

Sample Museums in Germany.—In the following report, dated June 27, 1903, Mr. Ozmun, our consul at Stuttgart, Germany, calls attention to the Sample Museum (Musterlager) of that city. A word as to the place occupied by a sample museum in German industrial and commercial life may not be out of place as a preface to Mr. Ozmun's report. For the last twenty or thirty years Germany has been doing a great deal of hard work to secure and to maintain a place in foreign markets. The number of the agencies employed to assist in this work is very large. From the huge subsidies granted by the government to the steamship companies down to the humble letter of a hillside laborer is a long way, but it is a way filled with all forms of effort. Some years ago there were formed all over the Empire, in connection with, and not infrequently independent of, the colonial movement, export unions. Among the most famous as well as most important of these, Stuttgart's and Dresden's may be mentioned. After a time it occurred to the directing agencies of these bodies that a good way to aid merchants and manufacturers was by gathering catalogues, samples, etc. Commissions, consisting of experts in commerce and manufactures, were sent into all parts of the world for the purpose of studying and reporting on foreign markets. Quite a number of such expert commissions are always on the road. There is one, at least, in the United States at the present time. It has at its head a Minister of State, a member of the Emperor's Cabinet. These commissions are authorized to collect samples. They are given power to do so, the union paying for them, the commissioners using their own discretion in the selecting. Consuls, too, are called on for samples, and often send valuable collections. On one occasion a commission sent by the Germans visited the Orient and collected a great many samples. These were afterward exhibited for several days in the halls and corridors of the Imperial Parliament. They were afterward sent to large industrial and commercial centers and put on exhibition for the benefit of the workmen and workwomen who could not afford a trip to Berlin. They were afterward divided among the sample museums—textile centers getting textiles and iron districts getting iron and steel products. The sample museum is an excellent auxiliary of the empire's industrial, industrial-art, and technical schools. While it would be hard to estimate their value in dollars and cents the German merchant and manufacturer have come to regard them as a part of the popular system of education.

The abstract, of which Mr. Ozmun's report is a *résumé*, says:

"Business in the trans-Atlantic countries was just as quiet as in Germany during the past year, on account of low prices for coffee and the decline in silver and also on account of political troubles and other unfavorable circumstances; and, although more visitors called at our institution (Stuttgart Musterlager), the total business of 1902 was about 15 per cent smaller than in 1901. Most of our customers bought only what they required for immediate use. North American firms only gave large orders, and it gives us great pleasure to be able to report an increase of trade with the United States.

"For the purpose of calling the attention of foreign buyers to our institution and to our continual exhibition of German industrial products, we have mailed a large number of circulars. The domestic as well as the foreign press helped us a great deal by making detailed reports regarding our institution, for which we wish to express our thanks.

"The number of firms giving orders at our institution and by mail was as follows:

1900	337
1901	342
1902	406

DETAILED STATEMENT OF ORDERS GIVEN.

Year.	At our office and by mail.	By agents.	By our branch in Hamburg.	Total.
1900	1,776	49	1,045	2,870
1901	1,772	33	1,050	2,855
1902	1,828	65	917	2,810

"The orders given at our office and by mail were divided among 506 firms.

"It has been our principle, ever since this institution was founded, to sell for cash only, and consequently our members suffered no losses.

"Several catalogues were mailed; the total of catalogues mailed so far is 9,920. The total number of letters received during the past year was 11,715, against 12,486 in 1901; the number of letters mailed, 16,290, against 17,620 in 1901.

"Our director visited, during the past year, Vienna, London, Bremen, Düsseldorf, and Frankfort, and made several new connections.

"Business with Greece increased a little through the efforts of our agents.

"Our branch in Hamburg (Deurer & Kaufmann, Hamburg, Africa house) also felt the general depression to a certain extent.

"Business is a little more active since the beginning of the current year, and we expect a larger total this year.

"Besides receiving large orders for metal ware of every description—clocks, jewelry, musical instruments, etc.—our branch in Hamburg has extended its machinery department and succeeded in receiving large orders for machines.

"We recommend, therefore, that members handling machinery should send their catalogues to our branch in Hamburg.

"Here in Stuttgart there has also been a decided improvement during the first four months of the current year. Exports to Australia especially are steadily increasing. The large stock on hand seems to be sold at last, and the foreign buyers are placing large orders."

Injurious Effect of German Meat-Inspection Law.—Vice-Consul-General Murphy sends the following translation from the Frankfurter Zeitung of June 22, 1903:

"Pork prices are now 20 per cent less than a year ago, and it is possible that as the summer advances there will be a further fall. How is it possible that in spite of the complete closing of the frontiers, in spite of the meat-inspection law, which renders importation difficult, prices have not risen? If the frontiers were opened to-day for the admission of foreign pork, the Agrarians would cry out that this importation was the cause of the low prices; but now we have the proof that this is not so. The abnormally high prices of the past two years have lessened the consumption, and some time will be required to again increase the consumption of pork by means of temptingly cheap prices. Through the chicanery of the provisions of the meat-inspection law, through the chicanery of the measures enforced against foreign meat on our German imperial frontiers (resorted to under the pretense of sanitary protection), other countries have been led to adopt similar measures against German products. Thus, for instance, after July 1 German meat products, be they Westphalian hams, Thuringian sausage, or Frankfort wuerstchen, will no longer be admitted into the United States, or only after undergoing the same troublesome and expensive inspection as that now enforced in Germany. The great sausage factories in Westphalia, which for twenty-five years have been exporting hundreds of thousands of sausages to the United States, are exposed to ruin, and the exportation of canned Frankfort sausages is likewise seriously threatened. Thus is closed a safety valve which was always before open whenever German pork prices fell to a low level. At such times much more than usual was formerly manufactured for foreign markets. Now this resource is lost, and the same people who thought they were playing their greatest trump in the enactment of the meat-inspection law, believing that it would hinder importation from abroad and thus keep the price of hogs at a high level in Germany, now find themselves deprived of the anticipated fruit of their policy."

Germans in Concepcion, Chile.—A foreign consular report of recent date says that Germany comes close behind England in selling goods to the Chileans at the port of Concepcion. Thither she sends cotton and woolen goods, clothes, linings, knit goods, furniture cloths, trimmings, ribbons, and cloakings; leather goods and leather; musical instruments; chemicals, dyes, and drugs; stone, glass, iron, and enameled wares; machines, agricultural tools, etc., of all kinds; technical and surgical instruments, preserves, toys, objects of art, lamps, cement, pianos, furniture, photographers' supplies, oils, weapons, and artificial flowers. Chile makes a great deal, if not most of her own most necessary or useful articles; hence a falling off in their importations has been observable. Among these articles are ordinary glass bottles and demijohns, matches, packing paper, blackings, blank books, tags, printed matter, shoes, etc.; brooms; ready-made clothing and cotton knit goods; flour, etc.; alcohol, liquors, beers and wines; mirrors, leather and leather goods, shot, twines, linseed oils; pastes, macaroni, and noodles; ordinary chocolates and sweetmeats, tea biscuits, straw hats, shirts, carriages and other vehicles, bits and spurs, brushes and drawing materials, woven-wire wares, furniture, gloves, billiard and ten-pin balls and pins, iron and brass bedsteads, galvanized-iron roofings, iron safes, railroad cars or coaches, small steamers, boilers, sulphuric acid, etc. For the production of these articles many raw and half-raw materials are imported.

The list indicates a desire on the part of the people in South America to manufacture as many as they can of the staples needed in their daily lives.

Effects of Dear Cotton in England.—The following article relative to the effects of dear cotton in England is translated from the Nachrichten für Handel und Industrie, of Berlin:

"The increase in prices for raw cotton is injuring the cotton industries of Great Britain. Lancashire spinners have come to the conclusion that it is possible to free themselves from their very unfavorable position by curtailing the production of cotton goods. The president of the Master Spinners' Association sent out a circular letter about the middle of May not only to members, but to all the spinners of the country, asking them to shut up shop during Whitsunday week and afterward on Mondays and Saturdays of each week. All agreed to do no work during the week indicated, but concluded to leave the question of closing Mondays and Saturdays open for further information and discussion. The Cotton Spinners and Manufacturers' Association agreed to do essentially the same thing. This is why the cotton mills of Lancashire were all closed during Whitsunday week and why quite a large number were not working on the Mondays and Saturdays after Whitsunday. The coal miners of the country are complaining about the decreased demand for furnace or boiler coal, due to movement in the cotton mills."

Demand for Pig Iron in Solingen.—Consul J. J. Langer, of Solingen, Germany, on June 26, 1903, writes to say that he has an inquiry from a party there for pig iron for malleable castings of all kinds, which the party in question would like to obtain from the United States. Any information obtainable will be referred by the consul to the inquirer.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1707, July 27.—The Suez Canal in 1902—Cuban Tariff on Domestic Animals and Coffee—Dried Sugar Beets as Food for Farm Animals—Wages in Cuba—Cairo International Chamber of Commerce.

No. 1708, July 28.—The Building of Dalny.

No. 1709, July 29.—*American Interests and Opportunities in Siberia—Transvaal Imports—Damaged Wool and Its Relation to Sheep Dips.

No. 1710, July 30.—*How to Increase Our Exports to India—Mint Machinery for King Menelek—Exports from Germany to the United States—Coal Trade at Gibraltar—British Engineering Standards Committee—Siberian Trade Notes—Industrial Activity in the Argentine Republic—Petroleum Residue as Fuel for Locomotives.

No. 1711, July 31.—*French-American Trade Requirements—Alcohol from Acetylene—*American Corn Meal and Hominy in France—Damages for Injuries in Railroad Accident in Germany.

No. 1712, August 1.—French Cotton Crisis—British Cotton Supply—British and German Cotton Supply—Imports at Corunna—Siberian Asbestos—German Association of Inventors.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

*The samples are on file in the Bureau of Statistics, Department of Commerce and Labor, Washington, D. C., and may be seen upon application by interested parties.

SELECTED FORMULÆ.

Glue to Form Paper Pads.—The following formulas for a glue suitable for forming paper into pads have been published:

I.

Glue	3½ ounces
Glycerin	8 ounces
Water, a sufficient quantity.	

Pour upon the glue more than enough water to cover it and let stand for several hours, then decant the greater portion of the water; apply heat until the glue is dissolved, and add the glycerin. If the mixture is too thick, add more water.

II.

Glue	6 ounces
Alum	30 grains
Acetic acid	½ ounce
Alcohol	1½ ounces
Water	6½ ounces

Mix all but the alcohol, digest on a water bath till the glue is dissolved, allow to cool and add the alcohol.

III.

Glue	5 ounces
Water	1 ounce
Calcium chloride	1 ounce

Dissolve the calcium chloride in the water, add the glue, macerate until it is thoroughly softened, and then apply heat until completely dissolved.

IV.

Glue	20 ounces
Glycerin	5 ounces
Syrupy glucose	1 ounce
Tannin	50 grains

Cover the glue with cold water, and let stand over night. In the morning pour off superfluous water, throw the glue on muslin, and manipulate so as to get rid of as much moisture as possible, then put in a water bath and melt. Add the glycerin and syrup, and stir well in. Finally dissolve the tannin in the smallest quantity of water possible, and add.

This mixture must be used hot.

V.

Glue	15 ounces
Glycerin	5 ounces
Linseed oil	2 ounces
Sugar	1 ounce

Soak the glue as before, melt, add the sugar and glycerin, continuing the heat, and finally add the oil gradually under constant stirring.

This, like the preceding, must be used hot.—Druggists' Circular and Chemical Gazette.

Liquid Glue.—From formulas for liquid glue which have been published we take the following:

I.

Dilute 1 part of official phosphoric acid with 2 parts of water and neutralize the solution with carbonate of ammonium. Add to the liquid an equal quantity of water, warm it on a water bath, and dissolve in it sufficient glue to form a thick syrupy liquid. Keep in well-stoppered bottles.

II.

Dissolve 3 parts of glue in small pieces in 12 to 15 of saccharate of lime. By heating, the glue dissolves rapidly and remains liquid, when cold, without loss of adhesive power. Any desirable consistency can be secured by varying the amount of saccharate of lime. Thick glue retains its muddy color, while a thin solution becomes clear on standing.

The saccharate of lime is prepared by dissolving 1 part of sugar in 3 parts of water, and after adding one-fourth part of the weight of the sugar of slaked lime, heating the whole to 65 deg. to 85 deg. C., allowing it to macerate for several days, shaking it frequently. The solution, which has the properties of mucilage, is then decanted from the sediment.

III.

Glue	200 parts
Diluted acetic acid	400 parts
Dissolve by the aid of heat and add:	
Alcohol	25 parts
Alum	5 parts

IV.

In a solution of borax in water, soak a good quality of glue until it has thoroughly imbibed the liquid. Pour off the surplus solution and then put on the water bath and melt the glue. Let cool down until the glue begins to set, then add, drop by drop, with agitation, enough acetic acid to check the tendency to solidification. If after becoming quite cold there is still a tendency to solidification, add a few drops more of the acid. The liquid should be of the consistency of ordinary mucilage at all times.

V.

Gelatin	100 parts
Cabinet makers' glue	100 parts
Alcohol	25 parts
Alum	2 parts
Acetic acid 20 per cent	800 parts

Soak the gelatin and glue with the acetic acid and heat on a water bath until fluid; then add the alum and alcohol.

VI.

Glue	10 parts
Water	15 parts
Sodium salicylate	1 part

VII.

Brown glue No. 2	2 pounds
Sodium carbonate	11 ounces
Water	3½ pints
Oil of clove	160 mins.

Dissolve the soda in the water, pour the solution over the dry glue, let stand over night, or till thoroughly soaked and swelled, then heat carefully on a water bath until dissolved. When nearly cold stir in the oil of clove.

By using a white glue, a finer article, fit for fancy work, may be made.—Drug. Circular.

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